UC IPM
Pest Management Guidelines:
DRY BEANS

Contents (Dates in parenthesis indicate when each topic was updated) October 2010

Continued next page . . .

An illustrated version of this guideline is available online at http://www.ipm.ucdavis.edu/PMG/selectnewpest.beans.html

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Table of contents, continued

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Updates: These guidelines are updated regularly. Check with your University of California Cooperative Extension Office or the UC IPM World Wide Web site for information on updates.

Note to readers: These guidelines represent the best information currently available to the authors and are intended to help you in making the best choices for an IPM program. Not all formulations or registered materials are mentioned. Always check the label and with local authorities for the most up-to-date information regarding registration and restrictions on pesticide use. Check with your agricultural commissioner for latest restricted entry intervals.

To be used with UC ANR Publication 3339PS2, *Color Photo Guide to Dry Bean Pests*

www.ipm.ucdavis.edu

Dry Beans Year-Round IPM Program Annual Checklist

Supplement to UC IPM Pest Management Guidelines: Dry Beans

These practices are recommended for a monitoring-based IPM program that reduces environmental quality problems related to pesticide use. Track your progress through the year using this form.

Water quality becomes impaired when pesticides move off-site and into water. Air quality becomes impaired when volatile organic compounds move into the atmosphere. Each time a pesticide application is considered, review the Pesticide Application Checklist at the bottom of this form for information on how to minimize environmental quality problems. This program covers the major pests of blackeye, common, and lima beans in the Central Valley. Details on carrying out each practice, information on additional pests, and additional copies of this form are available from the UC IPM Pest Management Guidelines: Dry Beans at http://www.ipm.ucdavis.edu/PMG.

✓ Done	**Preplant** **Mitigate pesticide usage to minimize air and water contamination.**
	Survey weeds in the current crop. ▪ Record your results. Manage weeds before planting within and adjacent to the field.
	Select field considering: ▪ Pest history (including current crop): o Weeds o Diseases o Insects o Nematodes ▪ Surrounding crops and vegetation. ▪ Soil conditions and water quality. ▪ Crop rotation.
	Select the cultivar. Consider treated seed for fields with a history of: ▪ Seedling diseases (*Pythium* and *Rhizoctonia* spp.) ▪ Seedcorn maggots ▪ Wireworm
	Calculate nitrogen budget and inoculate seed with appropriate *Rhizobium* bacteria.
	Prepare the field for planting, including laser leveling to correct drainage and runoff problems as needed.

✓ Done	**Planting to stand establishment** **Mitigate pesticide usage to minimize air and water contamination.**
	Consider seed handling and planting techniques that: ▪ Reduce cracking and splitting of seeds. ▪ Ensure appropriate planting depth, maximizing germination rate and reducing risk of seedling diseases.
	Inspect seedlings for damage. Manage if needed according to the PMGs.
	Manage irrigation.
	Survey weeds 4 weeks after planting. ▪ Record results. Cultivate beans to remove weeds, as necessary.
	Calculate nitrogen budget.

✓ Done	**Vegetative growth to flower bud** **Mitigate pesticide usage to minimize air and water contamination.**
	Look for pests or their damage on a weekly basis. Manage if needed according to the PMGs.

✓ Done	**Flower bud through bloom** **Mitigate pesticide usage to minimize air and water contamination.**
	Start sweep net sampling for lygus bugs at the early flower bud stage. ▪ Check fields twice weekly. Record results.
	While sweeping for lygus bugs, look for other pests or damage on a weekly basis. Manage if needed according to PMG.

✓ Done	**Pod fill** **Mitigate pesticide usage to minimize air and water contamination.**
	Continue sweep net sampling for lygus bugs. ▪ Record results. Manage if needed according to PMG.
	Continue looking for pests or their damage on a weekly basis. Manage if needed according to PMG.
	Survey weeds before harvest. ▪ Keep records. Remove nightshade plants if necessary.

✓ Done	**Harvest** **Mitigate pesticide usage to minimize air and water contamination.**
	Adjust combine to reduce mechanical damage and bean loss.
	Exercise care when threshing to ensure moisture content of seed below 15%.

✓ Done	**Postharvest** **Mitigate pesticide usage to minimize air and water contamination.**
	Carry out sanitation practices in the field to reduce the spread of: ▪ Weeds ▪ Diseases ▪ Nematodes ▪ Insects

✓ Done	****Pesticide application checklist**
	When planning for possible pesticide applications in an IPM program, review and complete this checklist to consider practices that minimize environmental and efficacy problems. ✓ Choose a pesticide from the UC IPM Pest Management Guidelines for the target pest considering: ▪ Impact on natural enemies and honeybees. ▪ Potential for water quality problems using the UC IPM WaterTox database (For more information, see http://www.ipm.ucdavis.edu/TOX/simplewatertox.html.) and impact on aquatic invertebrates (For more information, see *Pesticide Choice,* UC ANR Publication 8161, http://anrcatalog.ucdavis.edu/pdf/8161.pdf.). ▪ Chemical mode of action if pesticide resistance is an issue. ✓ Consider water management practices that reduce pesticide movement off-site. (For more information, see UC ANR Publication 8214, *Reducing Runoff from Irrigated Lands: Causes and Management of Runoff from Surface Irrigation in Orchards,* http://anrcatalog.ucdavis.edu/pdf/8214.pdf.) ▪ Choose sprayers and application procedures that keep pesticides on target. ▪ Identify and take special care to protect sensitive areas (for example, waterways or riparian areas) surrounding your application site. ▪ Review and follow label for pesticide handling, storage, and disposal guidelines. ▪ Check and follow restricted entry intervals (REI) and preharvest intervals (PHI). ▪ After an application is made, record application date, product used, rate, and location of application. Follow up to confirm that treatment was effective. ▪ Install an irrigation recirculation or storage and tail water return system. (For more information, see UC ANR Publication 8225, *Reducing Runoff from Irrigated Lands: Tailwater Return Systems,* http://anrcatalog.ucdavis.edu/pdf/8225.pdf. ▪ Limit irrigation to amount required using soil moisture monitoring and evapotranspiration (ET). ▪ Consider vegetative filter strips or ditches. (For more information, see *Vegetative Filter Strips*, UC ANR Publication 8195, http://anrcatalog.ucdavis.edu/pdf/8195.pdf.) ▪ Install sediment traps. ▪ Use polyacrylamide (PAM) tablets in furrows to prevent off-site movement of sediments. ▪ Redesign inlets and outlets into tailwater ditches to reduce erosion. ✓ Consider management practices that reduce air quality problems. ▪ When possible, choose pesticides that are not in emulsifiable concentrate (EC) form which release volatile organic compounds (VOCs). VOCs react with sunlight to form ozone, a major air pollutant.

General Information

SELECTING THE FIELD (12/08)

Well-chosen fields can result in fewer pests and better yields, so, consider the information below when evaluating a field for dry bean production:

PREVIOUS CROPPING HISTORY
Have pests of bean such as lygus bugs, mites, leafminers, seedling diseases, charcoal rot, white mold, nematodes, or problematic weeds been present in the field in recent years?

ADJACENT CROPS/FALLOW AREAS
Do these areas harbor any of the pests above? Are alfalfa, cotton, or safflower, which all harbor lygus bugs, growing nearby? Alfalfa can also be a source of armyworms, cutworms, darkling beetles, and cowpea aphids.

AGRONOMIC INFORMATION
Check which bean varieties have been planted in previous years, their planting and harvest dates, and yields. Determine if the field has supported successful bean production in the past.

ASSAY SOIL AND WATER
- Check for excessive salt and boron, and other mineral imbalances. Ask your local farm advisor about acceptable soil boron levels for your bean type.
- If there is a potential for herbicide residual from the previous crop, perform a soil herbicide bioassay. Residues may inhibit seedling growth.
- Identify soil type. Beans can grow in a variety of soil types, ranging from coarse sands to clay loams, provided that irrigation is managed to prevent water stress and water logging. If possible, choose a field with deep, uniform loamy soil. Avoid fields with major variations in soil type because it makes application of herbicides difficult as rates must be adjusted for soil type.
- Check irrigation water. If the quality of the irrigation water is unknown, assay for pH, salinity, and specific ion toxicities.
- Sample for root knot nematodes. Before planting beans, assay for nematodes if they have been a problem in a previous crop.

CONTINUOUS CROPPING
Although continuous cropping is not recommended, if one bean crop must follow another, treat any weed infestations before planting (see SPECIAL WEED PROBLEMS), and use treated seed if the field has soil pathogens. If a field is infested with a soil pathogen or weed, consider crop rotation. Fields to avoid, when possible, are those severely infested with:

- annual morningglory
- bermudagrass
- charcoal rot pathogens
- field bindweed
- johnsongrass
- nightshades
- nutsedges
- seedling diseases pathogens
- white mold pathogens

CROP ROTATION (12/08)

Rotating to a nonhost crop can significantly reduce pest populations in the field. The table below provides information on nonhost crops that interrupt certain dry bean-associated pathogen, nematode, and weed cycles.

Although longer nonhost crop rotations are ideal, often they are not economically feasible. A rotation of lesser duration is still beneficial but to a lesser degree. In general, avoid leguminous crops as rotation choices.

Use the table below to help identify appropriate rotational crops to use in your field.

Pest type	Suggested rotation cycle (years)	Nonhost crop options and other comments
DISEASES		
charcoal rot (ashy stem blight)	2–3	cereal crops
Fusarium root rot (*Fusarium solani* f. sp. *phaseoli*: common, blackeye)	3	Pathogen survives well without bean hosts, so rotation will not solve problem entirely, but cereal crops are the best choice.
Fusarium wilt	long term	Any crop but the bean variety that the species of *Fusarium* attacks.
Rhizoctonia solani	3–4	Any crop other than bean.
Pythium spp.	2–3	Small grains, as long as fully decomposed; summer fallow.
southern blight	2	corn, small grains, safflower
white mold	2-3	corn, small grains, safflower
NEMATODES—If your field has a history of nematodes, destroy volunteer beans. Most common weeds are hosts and rotations should be weed free.		
root knot nematode (*M. javanica*)	2–3	resistant tomato varieties; winter small grains followed by fallow period during summer; oats; Acala cotton varieties
root knot nematode (*M. incognita*)	2–3	resistant tomato varieties; winter small grains followed by fallow period during summer; oats; garlic, onions; weed-free alfalfa; resistant large limas (White Ventura N, Maria) baby limas (Cariblanco N) and blackeyes (CB 46)
WEEDS		
summer weeds	1–2	corn, selective herbicides, and cultivations
winter weeds	1–2	wheat or small grains and suitable herbicides
perennial weeds	2–3	cereal crops, summer fallow, herbicides

CULTIVAR SELECTION (12/08)

Where possible, choose bean varieties that are resistant to prevalent pathogens and nematodes. Base your choice on disease resistance, growth habit, seed quality, maturity, seed yield potential, area where adapted, and marketability. Use the tables below to help with decisions for blackeye, common, and lima bean varieties.

BLACKEYE (V*igna unguiculata*) VARIETAL CHARACTERISTICS

Line	Days to maturity		Nematode resistance	*Fusarium* wilt race 3	*Fusarium* wilt race 4	Grain size (g/100 seed)
	Planting to threshing 1st flush cut	Planting to threshing 2nd flush cut				
CB46	98	140	Rk	R	S	20-21
CB5	102	145	Rk	S	S	24-25
03-Sh-50[1]	102	145	Rk	R	R	24-25

Source: Jeff Ehlers, Botany and Plant Sciences, UC Riverside.

KEY:

Rk = Confers strong and moderate resistance to *M. incognita* and *M. javanica* root knot nematodes, respectively.

R = Resistant S = Susceptible

[1] Will be released in 2008, potentially under a different name. Certified seed of this new variety will be available for 2009 growing season.

LIMA BEAN (*Phaseolis lunatus*) VARIETAL CHARACTERISTICS

Type	Days to maturity (planting to threshing)	Resistance to:	
		Nematode (root knot)	Lygus bug
Baby Limas			
Mezcla (vine)	120	S	S
UC Cariblanco N (vine)	120	R	S
UC Luna (bush)	110	S	F
UC 302[1] (bush)	110	R (some races)	R
UC 279[1] (vine)	120	S	R
Large Limas			
UC White Ventura N[2] (vine)	140	R	S
Dompe 95 (bush)	130	S	S
UC 92 (bush)	130	S	S

Source: Steve Temple, Agronomy and Range Science, UC Davis.

KEY:

R = Resistant S = Susceptible F = Fairly resistant

[1] Due to be released 2009 or 2010

[2] Modest acreage on coast

COMMON BEANS (P*haseolis vulgaris*) VARIETAL CHARACTERISTICS

Class	Days to maturity	BCMV #1	BCMV #15	Root rot
Dark red kidney (bush)				
CA dark red kidne–	37–56	S	S	S
Charlevoix	37-48	S	S	S
Montcalm	36–51	R	R	S
Royal red	34–44	R	R	S
Light red kidney (bush)				
CA light red kidney	37–58	S	S	S
Linden	38–59	R	U	S
Manitou	42–50	S	S	S
Mecosta	50–53	R	R	S
Red kidney M	38–50	R	U	S
Redkloud	38–55	R	R	S
Redkote	40–51	R	R	S
Ruddy	33–42	U	U	U
Sacramento	38–52	S	S	S
Pink (vine)				
Gloria	21–35	R	R	T
Sutter	23–34	S	S	T
Pinquito	15–16	S	U	S
Small white				
Aurora (short; semi-vine)	11–13	R	R	T
FM 53 (short; semi-vine)	12–16	R	U	S
Sal (short; semi-vine)	12–20	R	U	T
Small white 59	11–13	R	U	U
Black turtle soup, (short; semi-vine)				
Black turtle soup T-39	12–20	S	S	T
Midnight	12–20	R	R	T
White kidney (bush)				
White kidney	35–47	U	U	ST

Source: Rachael Long, UCCE Yolo Co.

KEY:

R= Resistant S = Susceptible T = Tolerant U = Unknown

NITROGEN BUDGET (12/08)

It is critical to determine the correct rate for nitrogen fertilizer application. Grain legumes are very efficient at using available soil N and often adjust their symbiotic N fixation to the amount available in the soil. As a result, excess nitrogen in the soil can severely reduce a stand by inhibiting root nodule formation, over-stimulating vine growth and leading to delay in plant maturity and late-season decline, as well as providing favorable conditions for insects, molds, and bacterial diseases.

The rate of nitrogen that needs to be applied is based on residual soil nitrogen levels, the nitrogen fixation characteristic of the bean type, and soil type (fixation is limited in heavy clay soils). Some varieties, such as those of blackeyes, may not need additional nitrogen. The following table lists the nitrogen fixation rates of various dry bean varieties:

Nitrogen fixation rates characteristic of well-nodulated bean types

Bean Type	Rate (lb nitrogen/acre/season)
vine limas (baby/large)	80–100
blackeyes (cowpeas)	80–120
vine common	70
bush lima (large)	60
bush common	20–40
California early light red kidney	20
full-season kidney	40

PREPLANT APPLICATION

During final bed preparation, apply 20 to 40 lb nitrogen/acre, depending on the type of incorporation (into beds or sidedressing: 20 lb/acre; over entire field: 40 lb/acre). Use planter attachments to place nitrogen 4 to 6 inches below the surface of the soil and 4 to 6 inches beside the seed. Some blackeye growers apply up to 50 lb/acre of nitrogen to CB46, a relatively compact variety, to increase early crop growth and to allow it to compete more vigorously with weeds.

INOCULATING SEED WITH NITROGEN-FIXING BACTERIA

Optimal yield requires a proper balance between nitrogen applications and fixation through seed inoculation:

- Inoculate seed with *Rhizobium* bacteria before planting, or apply inoculant to seed row while planting.
- Wait 30 to 40 days for bacteria to infect seedling roots and develop nodules.

APPLICATIONS DURING CROP GROWTH

If the soil sample demonstrated the need for nitrogen in excess of the crops fixation capacity, then sidedress the root zone, 30 to 40 days after planting inoculated seed. Use ammonium nitrogen or insoluble nitrogen. Soluble nitrogen, in the form of UN32, is used by some growers in May or early June, and in winter for garbanzo beans.

To determine the amount of nitrogen fertilizer needed:

- Sample the soil for residual nitrate level.
- Identify the pounds of nitrogen your bean variety fixes/acre/season.
- Calculate the difference between available soil nitrogen levels and what your variety will fix to get the application rate.
- If you have heavy clay soil, check with your farm advisor.

MANAGING IRRIGATION (12/08)

Frequency of crop irrigation depends upon plant growth, root development, water-holding capacity of the soil, and the water use through evapotranspiration. Compared to other crops, beans have a relatively poor root system. About one month after planting, when visual signs of moisture stress are first noted, bean plants typically have removed about 50% of the available soil moisture from the 6 to 12 inch depth, but at 3 feet, only about 10%. Baby limas and blackeyes have the best root systems while early pinks are better than red kidney.

Research and production experience have shown that common beans grown in the San Joaquin and Sacramento valleys on loam soils will require frequent but light irrigation every 6 to 8 days. In coastal areas, 14- to 18-day irrigation intervals are common. Consumptive use (evapotranspiration) of common beans ranges from 20 to 25 inches per season, depending upon the variety and production area of the state. Consumptive use is the amount of water that evaporates from the soil plus the amount transpired by the bean plants. It does not include the loss of water from head-ditch seepage and evaporation or the tail-water loss. Therefore, depending upon the efficiency of the irrigation system, the amount of water needed will range from 25 to 40 inches per year.

Summer beans are irrigated in a number of ways in California. For most common beans, large limas, and bush baby limas, furrow irrigation is the usual method, but sprinklers are popular in some areas of the state, especially on shallow soils or soils high in clay content. Most vine baby lima beans in the Sutter Basin of Sacramento Valley are subirrigated using perimeter ditches. Subirrigation is also practiced for lima production in the Delta region. However, because common beans have a poor root system compared to limas, they are usually not subirrigated.

The foliage of common bean plants darkens in color when moisture stressed; however, when water is applied, the color will lighten. The difference in plant color is readily seen between irrigated and non-irrigated areas. If bean plants are moisture-stressed, lower leaves, flowers, and small pods may drop. If common beans are severely water stressed during the growing season, yields will be lower as will quality, because the weakened plants may not be able to recover.

IRRIGATING PROBLEM

Furrow irrigation can easily saturate soils high in clay content and create an environment unsuitable for bean roots. Frequently, *Rhizoctonia*, *Fusarium*, or *Pythium* fungi will infect bean roots in wet soils and may reduce stands, vigor, and yield. In blackeye production, even if no pathogen is involved, plants with roots in saturated soil will turn yellow because of an inability of the roots to take up iron when there is no oxygen in the soil. With some irrigation systems and with some soils, irrigating every other row when plants are young reduces the amount of water used that might drain below the root zone and avoids saturated soils. Use sprinkler irrigation on soils high in clay to avoid root disease problems (However, note that the cost of extra electrical power increases bean production costs.)

Another approach to irrigating on clay soils is to form furrows on 60-inch centers, and shape the beds flat on top. Use a bed that is wider than the conventional 30 or 40 inch width. Plant beans in rows of 28 to 30 inches apart. Make irrigation runs 600 to 800 feet long, if possible, and no longer than 1,200 feet. Using wider beds leaves an area on the bed unsaturated, thereby allowing oxygen to remain in the soil for roots. This wide-bed system has no practical application on loamy soils and should not be used on silty soils where water penetration is a problem.

Soils with a high silt content present another challenge to growing common beans. These soils absorb moisture well after a cultivation, but after a few irrigations, they seal and become almost impervious to water penetration. After the bean plants close over the row, cultivating equipment cannot be driven in the fields. A good sprinkler system works well in supplying water to beans grown on problem soils.

MONITORING DURING STAND ESTABLISHMENT (12/08)

As soon as the crop emerges, observe the stand for overall quality. Use the table below and the photo identification page (*available online*) to help identify pests and pest damage.

What problem looks like:	Check for:	Possible cause(s):
blank spots	**seeds present, but failed to emerge:**	
	rotting seeds	seedling diseases
	seeds planted too shallowly or deeply	planting technique
	tiny, slender, white centipedelike pests with 11 to 12 pairs of legs and prominent antennae	symphylans
	maggot(s) feeding on seeds	seedcorn maggot
	shiny, slender, cylindrical, hard-bodied, yellow to brown larvae in soil	wireworms
	birds foraging in field	birds
	seeds or seedlings dead or missing:	
	tiny, slender, white centipedelike pests with 11 to 12 pairs of legs and prominent antennae in soil	symphylans
	shiny, slender, cylindrical, hard-bodied, yellow-to-brown larvae in soil	wireworms
	presence of mounds	gophers
	maggots in soil	seedcorn maggot
	dead seedlings	seedling diseases
	birds foraging in field	birds
slow emergence; poor stand establishment	maggots feeding on seedling roots	seedcorn maggot, possible herbicide injury, seed planted too deeply, not enough moisture
seedling collapse soon after emergence	maggots feeding on seeds	seedcorn maggot
	tiny, slender, white centipedelike pests with 11 to 12 pairs of legs and prominent antennae in soil	symphylans
	shiny, slender, cylindrical, hard-bodied, yellow to brown larvae in soil	wireworms
	dark discolored roots; damping-off	seedling diseases
	seedling roots eaten off	wireworms seedcorn maggot gophers
leaf damage	holes or skeletonized areas on leaves; presence of green beetles with black spots	cucumber beetles
	leaves curled downward; sticky, shiny leaves; presence of aphids	aphids
	leaves cupped upward; ragged-looking plants	thrips, possible herbicide injury
	threadlike twisting lines in leaves	leafminers
stunted seedlings	sticky, shiny leaves; presence of aphids	aphids
	ragged-looking plants	thrips, possible herbicide injury
seedling leaves or stem eaten	seedling leaves or stem eaten off	darkling beetles, rabbits, wireworms
seedling cut off below or at soil line	presence of smooth-skinned caterpillars; roll into a C-shape when disturbed	cutworms
	presence of black or bluish-black to rusty brown beetles	darkling beetles
atypical color	abnormal coloring of any kind	seedling diseases, nutrient imbalance, herbicide toxicity, viruses, boron or salt toxicity

MONITORING DURING VEGETATIVE GROWTH (12/08)

During the period of vegetative growth, walk the fields at least once weekly to observe overall stand quality. Use the table below and the photo identification page (*available online*) to help identify pests and pest damage.

What the problem looks like:	Check for:	Possible cause(s):
collapsed, wilting, or dying plants	water-soaked lesions extending up stem; band of dead stem tissue	*Pythium* spp.
	yellowing plants; brick-red discoloration internally in roots and extending into above ground stems	Fusarium wilt (blackeyes)
	charcoal-like dust on stem surface	charcoal rot
	brick-red or brown external lesions on belowground stems and tap roots; small red flecks under lesion surface when scraped	Fusarium root rot
yellowing leaves (may also be a result of saturated soils)	leaves yellow or appear dry and curl slightly; honeydew or sooty mold present	whiteflies
	portions of leaves may yellow; leaves distorted	thrips
	sunken, red, oval spots at stem base and stem below soil; discrete, reddish brown lesions on upper tap roots of older plants	Rhizoctonia root or stem rot
	if the crop is blackeyes, has the field recently been irrigated	N deficiency
	wilting (starting in lower leaves); entire plant yellows; red-brown streaking inside stem (seen if cut open)	Fusarium yellows or wilt (common beans)
mottled, distorted leaves	light green-yellow and dark green mosaic pattern; puckering, blistering, distortion, downward curling, and rolling	bean common mosaic virus
leaves with holes; skeletonized leaves	presence of mottled, olive-green to almost black caterpillars; or, black caterpillars with prominent yellowish stripe and several bright stripes on each side	armyworms
	presence of green caterpillars that arch back when crawling	loopers
	presence of hairy caterpillars	saltmarsh caterpillar
	green beetle with black spots	cucumber beetle
leaves with mines	slender, winding trails or large, whitish blotches	leafminers
curled leaves	sticky, shiny leaves; black sooty mold	aphids
	downward cupping, puckering, wrinkling, and thickening of infected leaves; leaves brittle, dark green; plant with shortened internodes and stunted	curly top
leaves with spots	irregularly shaped spots bordered by lemon-yellow ring	common bacterial blight
leaves with stippling	very fine white or yellow stippling; fine webbing on leaf undersurface	spider mites
	white stippling on upper leaf surface; tiny, dark, varnishlike spots and small, white cast skins on lower leaves	leafhoppers

MONITORING DURING FLOWER BUD THROUGH BLOOM

(12/08)

During the period of flower bud through bloom, start sweep sampling for lygus bugs twice weekly. Also look at overall stand quality and use the table below and the photo identification page (*available online*) to help identify other pests and damage.

What the problem looks like:	Check for:	Possible cause(s):
collapsed, wilting, stunted, or dying plants	charcoal-like dust on stem surface	charcoal rot
	water-soaked lesions on stem	*Pythium* spp.
	yellowing leaves; center of the root and stem have brown discoloration (seen when cut open)	Fusarium wilt (blackeyes)
	brick-red lesions on below ground stems, tap roots that eventually turn brown	Fusarium root rot
	root galling; brown-black root lesions	nematodes
yellowing leaves (may also be a result of saturated soils)	leaves yellow or dry and slightly curled; honey-dew or sooty mold sometimes present	whitefly
	striking yellow mottle	alfalfa mosaic
	if the crop is blackeyes, has the field recently been irrigated	N deficiency
mottled, distorted leaves	striking yellow mottle	alfalfa mosaic
	green-yellow and dark green mosaic pattern on leaves; discoloration usually accompanied by puckering, blistering, downward curling	bean common mosaic
	bright, yellow to green mosaic or mottling; leaves distorted, cupped downward, and wrinkled	bean yellow mosaic
damaged flower buds and blossoms	missing blossoms and plant bugs	lygus bugs, stink bugs
leaves with holes; skeletonized leaves	presence of mottled, olive-green to almost black caterpillars; or, black caterpillars with prominent yellowish stripe and several bright stripes on each side	armyworms
	presence of green caterpillars that arch backs when crawling	loopers
	presence of hairy caterpillars	saltmarsh caterpillar
	green beetle with black spots	cucumber beetle
leaves with mines	slender, winding trails or large, whitish blotches	leafminer
curled leaves	sticky, shiny leaves; black sooty mold; presence of aphids	aphids
leaves with spots	irregularly shaped spots bordered by a lemon-yellow ring; dead brown tissue in center of larger spots	common bacterial blight
	necrotic spots on infected leaves; yellow dots	alfalfa mosaic
leaves with stippling	very fine white or yellow stippling; fine webbing on leaf undersurface	spider mite
	white stippling on upper surface of leaf; tiny, dark, varnishlike spots and small, white cast skins on lower surface of leaf	leafhopper

MONITORING DURING POD FILL (12/08)

During the period of pod fill, continue sweep sampling for lygus bugs twice weekly. Also look at overall stand quality and use the table below and the photo identification page (*available online*) to help identify other pests and damage.

What the problem looks like:	Check for:	Possible cause(s):
collapsed, wilting, stunted, or dying plants	watery rot on stems, leaves, and pods; white webbing; tiny black kernels (sclerotia) stuck to infected plant; yellow flagging	white mold
	yellowing leaves; brown discoloration inside root and stem (seen when cut open)	Fusarium wilt (blackeyes)
	leaf senescence and defoliation	cutout (blackeyes) early decline (common, limas)
damaged pods	distorted pods; pitting and blemishing on seeds	stink bugs lygus
leaves with holes; skeletonized leaves	presence of mottled, olive-green to almost black caterpillars; or, black caterpillars with prominent yellowish stripe and several bright stripes on each side	armyworms
	presence of green caterpillars that arch back when crawling	loopers
	presence of hairy caterpillars	saltmarsh caterpillar
leaves with mines	slender, winding trails or large, whitish blotches	leafminer
leaves with spots	irregularly shaped spots bordered by a lemon-yellow ring; dead brown tissue in center of larger spots	common bacterial blight
leaves with stippling	very fine stippling (yellow or white); fine webbing on leaf undersurface	spider mite
	white stippling on upper leaf surface; tiny, dark, varnishlike spots and small, white cast skins on lower leaves	leafhopper

POSTHARVEST SANITATION (12/08)

Field sanitation is important for reducing certain overwintering pests before the next growing season. Carry out sanitation practices in the field to reduce the spread of:

- *Weevils on blackeye beans*. Eliminate potential sources of beans leftover in production areas such as:
  - in or on planting hoppers, or harvesters following harvest
  - broken sacks of seed beans
  - animal feed programs
  - fields after harvest
  - warehouse areas
- *Diseases.* Plow under bean debris in fields infected with anthracnose (common, lima) or halo blight immediately after harvest. Bury plant refuse to reduce sources of southern blight.
- *Seedcorn maggots and weeds.* Disc or plow early in the season incorporating residues from the previous crop and destroying weed growth.
- *Nematodes.* Wash soil from equipment before moving from infested to noninfested fields.

RELATIVE TOXICITIES OF INSECTICIDES AND MITICIDES USED IN DRY BEANS TO NATURAL ENEMIES AND HONEY BEES (10/10)

Common name (trade name and formulation)	Mode of action[1]	Selectivity[2] (affected groups)	Predatory mites[3]	General predators[4]	Parasites[4]	Honey bees[5]	Duration of impact to natural enemies[6]
acephate (Orthene SP)	1B	broad (insects, mites)	H	H	M/H	I	moderate
aldicarb (Temik) at planting	1A	broad (insects, mites)	M	M	M	IV[7]	long
Bacillus thuringiensis ssp. *aizawai*	11.B1	narrow (caterpillars)	L	L	L	IV	short
Bacillus thuringiensis ssp. *kurstaki*	11.B2	narrow (caterpillars)	L	L	L	IV	short
bifenazate (Acramite)	UNC	narrow (spider mites)	L	L	L	III	short
carbaryl (Sevin S)	1A	broad (insects, mites)	M/H	H	H	I	long
carbaryl (Sevin XLR Plus)	1A	broad (insects, mites)	L	H	H	I[8]	long
cryomazine (Trigard)	17	narrow (leafminers)	L	L	L	III	short
dicofol (Dicofol 4E)	UNC	narrow (pest mites and mites)	H	M	M	IV	long to beneficial mites
dimethoate (EC)	1B	broad (insects, mites)	H	H	H	I	long
lambda-cyhalothrin (Warrior)	3	broad (plant bugs, beetles, caterpillars)	H	H	H	I[9]	moderate
malathion (EC)	1B	broad (insects, mites)	M	H	H	II	moderate
methomyl (Lannate SP)	1A	broad (insects , mites)	H	H	H	III	moderate
propargite (Omite)	12C	narrow (pest mites)	M[10]	L	L	IV	short
spinetoram (Radiant)	5	narrow (caterpillars, thrips, whiteflies, aphids, scales, leafminers)	L	M[11]	L/M	III	moderate[12]
spinosad (Entrust, Success)	5	narrow (caterpillars, thrips, whiteflies, aphids, leafminers)	L	M[11]	L/M	III	short to moderate[11]
zeta-cypermethrin (Mustang)	3	broad (insects, mites)	H	M	M	I	moderate

H = high M = moderate L = low — = no information

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/. UNC = MOA uncharacterized

2 Selectivity: *broad* means it affects most groups of insects and mites; *narrow* means it affects only a few specific groups.

3 Generally, toxicities are to western predatory mite, *Galendromus occidentalis*.

4 Toxicities are averages of reported effects and should be used only as a general guide. Actual toxicity of a specific chemical depends on the species of predator or parasite, environmental conditions, and application rate.

5 Ratings are as follows: I = Do not apply to blooming plants; II = Apply only during late evening; III = Apply only during late evening, night, or early morning; and IV = Apply at any time with reasonable safety to bees. For more information, see *How to Reduce Bee Poisoning From Pesticides*, Pacific Northwest Extension Publication PNW591.

6 Duration: *short* means hours to days; *moderate* means days to two weeks; and *long* means many weeks or months.

7 Not hazardous to bees when applied at least 4 weeks before bloom.

8 If rate is 1.5 lb a.i. or less and dilution not greater than 1:19, rating is II.

9 If rate is 0.02 lb a.i./acre, rating is II.

10 Use lowest rates for best management of western predatory mite/spider mite ratio.

11 Toxic against some natural enemies (predatory thrips, syrphid fly and lacewing larvae, beetles) when sprayed and up to 5-7 days after, especially for syrphid fly larvae.

12 Residual is moderate if solution is between pH of 7 to 8.

Acknowledgements: This table was compiled based on research data and experience of University of California scientists who work on a variety of crops and contribute to the Pest Management Guideline database, and from Flint, M.L. and S.H. Dreistadt. 1998. *Natural Enemies Handbook: An Illustrated Guide to Biological Pest Control*, ANR Publication 3386.

Arthropods

APHIDS (12/08)

Scientific Names: Cowpea aphid: *Aphis craccivora*
Bean aphid: *Aphis fabae*
Pea aphid: *Acyrthosiphon pisum*
Green peach aphid: *Myzus persicae*

DESCRIPTION OF THE PESTS

The two most common species encountered on beans are the cowpea aphid and the bean aphid. The cowpea aphid, which is also common on black-eye beans (cowpeas), is shiny black with legs and antennae that are white to pale yellow with black tips. The bean aphid is slightly larger than the cowpea aphid, and dark olive-green to black with light-colored legs. The pea aphid is a relatively large, green, somewhat shiny aphid.

DAMAGE

Aphids damage plants by: (1) sucking plant sap which causes heavily infested leaves to curl and stunts plants; (2) excreting honeydew which causes sticky, shiny leaves to ultimately turn black because of a sooty-mold fungus growth; and (3) spreading plant diseases (a large number of viruses are vectored by aphids). Infestations frequently are localized with heavily infested leaves curled downward.

MANAGEMENT

Be sure to assess levels of biological control when evaluating aphid populations. Frequently, parasites and predators prevent aphid infestations from becoming established throughout a field. Temperatures greater than 85°F frequently inhibit buildup of large densities of pea and green peach aphids.

Biological Control

Common predators of aphids in beans include lady beetles, syrphid flies, and lacewings. Parasitic wasps attack each of the common aphid species, turning them into hard, crusty mummies.

Organically Acceptable Methods

Biological control is organically acceptable.

Monitoring and Treatment Decisions

Aphid control in beans is not always necessary. The decision to treat for aphids is based mainly on visual inspection and the stage of crop development. Measurable thresholds are not available. Begin inspecting for aphid problems along with other pests and their damage when the crop emerges. Continue looking through the vegetative growth and flower bud to bloom periods.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.			
A. MALATHION 8 EC MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: Highly toxic to honey bees; do not apply when bees are present.	1.5 pt	12	1
B. DIMETHOATE 2.67 lb/gal EC MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: Ground or air application. Highly toxic to honey bees; do not apply when bees are present.	1–1.5 pt	48	0

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

ARMYWORMS (12/08)

Scientific Names: Beet armyworm*: Spodoptera exigua*
Western yellowstriped armyworm: *Spodoptera praefica*

DESCRIPTION OF THE PESTS

Eggs of the beet armyworm are deposited in a mass that is covered with a white cottony material. The larvae are about 1.25 inches long when full grown. They are mottled olive green to almost black. Eggs of the western yellowstriped armyworm are similar to those of the beet armyworm. The egg masses are larger and covered by a gray cottony material. The larvae attain a length of 1.5 to 2.0 inches, are black with a prominent yellowish stripe and several narrow bright ones on each side of the body. An intense black spot is usually visible on each side of the first legless segment behind the head.

DAMAGE

Armyworms skeletonize leaves when feeding in colonies shortly after hatching. Larvae that are half grown or more will feed singly on leaves and bean pods. Damaged pods will have holes in the pod and beans.

MANAGEMENT

While armyworms may be present anytime from June through September, populations are usually most damaging in late summer. In those rare instances where control measures are required, the beet armyworm is more difficult to control than the western yellowstriped armyworm. Insecticide applications will be most effective if applied against small larvae.

Biological Control
Common natural enemies of armyworms include the parasite *Hyposoter exiguae* and numerous general predators including assassin bugs, damsel bugs, and spiders.

Organically Acceptable Methods Biological control and sprays of *Bacillus thuringiensis* are organically acceptable.

Monitoring and Treatment Decisions
Start inspecting for armyworm damage along with other pests and their damage during the vegetative growth period. Continue looking during the flower bud to bloom and pod fill periods.

Specific treatment thresholds have not been established for armyworms on beans and treatment is seldom necessary.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.			
A. ACEPHATE (Orthene) 75 SP	0.67 lb	24	14
MODE OF ACTION GROUP NUMBER[1]: 1B COMMENTS: May result in mite outbreaks. Highly toxic to honey bees; do not apply when bees are present. Ground or air application.			
B. METHOMYL* (Lannate SP)	0.5–1 lb	48	14
MODE OF ACTION GROUP NUMBER[1]: 1A COMMENTS: Highly toxic to honey bees; do not apply when bees are present. Do not apply more than 4.5 lb a.i./acre/crop.			

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
C. BACILLUS THURINGIENSIS ssp. AIZAWAI#			
(various products)	Label rates	4	0
MODE OF ACTION GROUP NUMBER[1]: 11.B1			
COMMENTS: Does not destroy natural enemies of corn earworm. Control is maximized by thorough coverage and by making applications when larvae are small.			
D. CARBARYL*			
(Sevin) 80S	1.25–1.875 lb	12	see comments
(Sevin) XLR Plus	1–1.5 qt	12	see comments
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: For use on western yellowstriped armyworm. May result in outbreak of spider mites. Do not use on lentils in California. XLR Plus formulation is the least toxic to honey bees when direct application to bees is avoided and the spray residues have dried. Apply from late evening to early morning when bees are not foraging. Do not apply within 14 days of grazing or harvest for forage, within 3 days of harvest of fresh beans or peas, and within 21 days of harvest of dried beans, peas, seed, or hay.			
E. LAMBDA-CYHALOTHRIN*			
(Warrior with Zeon)	3.84 oz	24	see comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: May cause outbreaks of mites. Preharvest interval (P.H.I.) is 7 days for succulent shelled or edible podded crops and 21 days for dried shelled crops.			
F. ZETA-CYPERMETHRIN*			
(Mustang)	4.3 oz	12	see comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: May cause outbreaks of mites. Preharvest interval (P.H.I.) is 1 day for succulent shelled or edible podded crops and 21 days for dried shelled crops.			

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

CORN EARWORM (12/08)

Scientific Name: *Helicoverpa zea*

DESCRIPTION OF THE PEST

Corn earworm moths are most active during evening and night. They are about 0.75 inch long, rather robust, with a wing span of 1 to 1.5 inches, and adults range in color from olive green, to tan, to dark reddish brown in color. Young larvae are greenish with black heads and conspicuous black hairs on the body. Fully developed worms are about 1.5 inches long and range in color from pale green or pinkish to brown.

DAMAGE

The corn earworm may be present throughout the season but is most abundant during August and September. In beans, larvae feed on leaves, buds, flowers, and within pods, often damaging the beans.

MANAGEMENT

Biological Control

Many predators and parasites attack corn earworm eggs, including several species of *Trichogramma*. Most parasitized eggs turn black, but there may be a lag period before they do so. Generalist predators such as lacewings, minute pirate bugs, and damsel bugs feed on corn earworm eggs and small larvae.

Organically Acceptable Methods Biological control and sprays of *Bacillus thuringiensis* are organically acceptable.

Monitoring and Treatment Decisions

Sampling should start at bloom in conjunction with sampling for lygus bug populations. Inspect the sweep net for small worms. While sweeping is not an effective sampling method for corn earworms, the presence of small worms in the net indicates a problem may be developing. Beating and inspecting for worms on pans, sleds or sheets will provide some indication of the presence of small worms. There is no precise economic threshold established for initiating control for corn earworm on beans. On dry beans, treat when small worms appear in the sweep net and can be found generally throughout the field when young pods are present on plants.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. ACEPHATE
(Orthene) 75 SP — 1–1.33 lb — 24 — 14
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Ground or air application. Highly toxic to honey bees; do not apply when bees are present. Do not feed treated forage, hay, or straw to livestock or use green pods for human food.

B. METHOMYL*
(Lannate SP) — 0.5–1 lb — 48 — 14
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: Highly toxic to honey bees; do not apply when bees are present. Do not apply more than 4.5 lb a.i./acre/crop.

C. BACILLUS THURINGIENSIS ssp. KURSTAKI#
(various products) — Label rates — 4 — 0
MODE OF ACTION GROUP NUMBER[1]: 11.B2
COMMENTS: This material does not destroy natural enemies of corn earworm. Control is maximized by thorough coverage and by making applications when larvae are small.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
D. SPINETORAM			
(Radiant) SC	4-8 fl oz	4	28
MODE OF ACTION GROUP NUMBER[1]: 5			
E. CARBARYL*			
(Sevin) XLR Plus	1–1.5 qt	12	see comments
(Sevin) 80S	1.875 lb	12	see comments
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: May result in outbreak of spider mites. Do not use on lentils in California. XLR Plus formulation is the least toxic to honey bees when direct application to bees is avoided and the spray residues have dried. Apply from late evening to early morning when bees are not foraging. Do not apply within 14 days of grazing or harvest for forage, within 3 days of harvest of fresh beans or peas, and within 21 days of harvest of dried beans, peas, seed, or hay.			
F. LAMBDA-CYHALOTHRIN*			
(Warrior with Zeon)	3.84 oz	24	see comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: May cause outbreaks of mites. Preharvest interval (P.H.I.) is 7 days for succulent shelled or edible podded crops and 21 days for dried shelled crops.			
G. ZETA-CYPERMETHRIN*			
(Mustang)	4.3 oz	12	see comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: May cause outbreaks of mites. Preharvest interval (P.H.I.) is 1 day for succulent shelled or edible podded crops and 21 days for dried shelled crops.			

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

CUCUMBER BEETLES (12/08)

Scientific Names: Western spotted cucumber beetle: *Diabrotica undecimpunctata undecimpunctata*
Western striped cucumber beetle: *Acalymma trivittatum*

DESCRIPTION OF THE PESTS

Cucumber beetles are frequently abundant in bean/pea fields, but damage is usually insignificant. The western spotted cucumber beetle is green, 0.25 inch long, and has eleven black spots on its wing covers. The whitish worm-like larvae feed on roots of corn and sweet pea as well as on grasses. When surrounding areas dry up, adults swarm into the field. A close relative, the western striped cucumber beetle, is yellowish and has three black lines down its back. The larvae live in the soil where they feed on roots, but adults are foliage and flower feeders.

DAMAGE

Cucumber beetles defoliate bean foliage and may damage bean flowers and buds.

MANAGEMENT

Specific treatment thresholds have not been established for these foliage feeders. Start inspecting plants for cucumber beetle damage along with other pests and their damage when the crop emerges. Continue looking through the vegetative growth and flower bud to bloom period. Late-season infestations are insignificant. If damaging numbers are encountered during mid-season and excessive foliage loss may reduce crop production, a treatment may be warranted.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. CARBARYL*

(Sevin) 80S	1.25 lb	12	see comments
(XLR PLUS)	1 qt	12	see comments

MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: May result in outbreak of spider mites. Do not use on lentils in California. XLR Plus formulation is the least toxic to honey bees when direct application to bees is avoided and the spray residues have dried. Apply from late evening to early morning when bees are not foraging. Do not apply within 14 days of grazing or harvest for forage, within 3 days of harvest of fresh beans or peas, and within 21 days of harvest of dried beans, peas, seed, or hay.

B. MALATHION — Label rates — see label — see label
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Highly toxic to honey bees. Do not apply when bees are present.

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

CUTWORMS (12/08)

Scientific Names: Black cutworm: *Agrotis ipsilon*
Variegated cutworm: *Peridroma saucia*, and others

DESCRIPTION OF THE PESTS

Adults are moths approximately 1 inch long with a wing span of 1.25 to 2 inches and vary widely in coloration. Eggs are somewhat flattened on top, white to dull or off-white in color, and ribbed. They are generally deposited in massed rows. Eggs may be deposited on crop foliage, but are frequently found on weeds. Fully grown larvae range from 1 to 1.75 inches in length.

Cutworms are most active and cause the most damage during spring and early summer months. The larvae normally hide under debris on the soil surface during the day, but are active, voracious feeders at night. Some cutworms climb into the host plant to feed, but many stay on the ground, cutting seedling host plants off at or just below the soil surface.

DAMAGE

Cutworms cut young plants off at the base or near the ground level. Usually, it is necessary to dig in the soil to find cutworm larvae and to determine the extent of the infestation and the size of the cutworms involved.

MANAGEMENT

Cultural Control
Eliminate weeds 2 weeks before planting both within and adjacent to the field to minimize cutworm problems.

Organically Acceptable Methods Cultural control is acceptable in an organically certified crop.

Treatment Decisions Start inspecting plants for cutworm damage along with other pest damage when the crop emerges. If the cutworm population is reducing the plant stand, treat during the seedling stage. Frequently, the damage is most serious at the edges of a field, but stand loss may occur in a spotty pattern throughout the field.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. CARBARYL
(Sevin) 5% Bait — 30 lb — 12 — see label
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: Ground or air application. Avoid direct application to lakes, streams, ponds. Do not apply when weather conditions favor drift from treated areas. Do not contaminate water, food, or feed when cleaning equipment or disposing of wastes.

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

DARKLING BEETLE (12/08)

Scientific Name: *Blapstinus* spp.

DESCRIPTION OF THE PEST

Darkling beetle adults are from 0.13 to 0.25 inch (3.5 to 6 mm) long and vary from black or bluish black to rusty brown. They may be hidden by dust or a thin veneer of soil. Larvae are cylindrical, wirewormlike, soil-inhabiting worms that are light yellow to dark brown and range from 0.03 to 0.33 inch (0.8 to 8 mm) in length. They are often referred to as false wireworms.

Development from egg to adult may require 50 days during summer. Eggs hatch in 3 to 6 days and there can be five larval instars. The pupal period lasts 8 days or longer. Beetles are frequently numerous in spring and early summer and may be seen running on the ground but are more frequently found under clods or organic debris during daylight hours.

DAMAGE

Damage is often caused during the seedling stage of plant growth. Young plants may be girdled or cut off at or below the soil surface. After the plants reach a height of 5 to 6 inches, darkling beetles are usually not a problem.

MANAGEMENT

Start inspecting plants for darkling beetle damage along with other pests and their damage when the crop emerges. Treat if darkling beetles are causing a reduction in stand of the young plants. Infestations are frequently spotty, and damage and treatment may be confined to field margins or specific portions of the field.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. CARBARYL
(Sevin) 5% Bait — 30 lb — 12 — see label
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: Ground or air application. Avoid direct application to lakes, streams, ponds. Do not contaminate water, food, or feed when cleaning equipment or disposing of wastes.

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

EMPOASCA LEAFHOPPERS (12/08)

Scientific Names: *Empoasca fabae* and *Empoasca solana*

DESCRIPTION OF THE PESTS

Several species of leafhoppers are found in dry beans with *Empoasca fabae* and *E. solana* being the most common. They are nearly identical morphologically and can only be distinguished by experts. The damage they cause is also nearly identical as are the treatment guidelines.

Empoasca leafhoppers are small (0.125 inch [3 mm] long), bright green, wedge-shaped insects. The small, wingless nymphs (immatures) are also wedge shaped and green and move rapidly forward, backward, and from side to side. Both adults and immatures are found primarily on the underside of leaves.

DAMAGE

Empoasca leafhoppers cause a symptom known as hopperburn in which the leaf margins turn yellow, particularly at the leaf tip, and these areas soon become necrotic. The entire leaf may become yellowed and the symptoms often resemble virus symptoms. The presence of adult and immature leafhoppers on the undersurface of the leaf serve to distinguish leafhopper injury from virus symptoms or mineral deficiencies.

MANAGEMENT

Start inspecting plants for leafhopper damage along with other pests and their damage during the vegetative growth period. Continue looking through the flower bud-to-bloom and pod fill periods. Look for plant damage and Empoasca leafhoppers on the undersides of leaves. Examine a minimum of 10 leaves from 10 plants in at least four areas of the field. Measurable thresholds are not available.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.			
A. DIMETHOATE 2.67 lb/gal EC	1–1.5 pt	48	0
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Ground or air application. Do not feed treated vines to livestock. Use of product may result in mite outbreak. Highly toxic to honey bees; do not apply when bees are present.			
B. ACEPHATE (Orthene) 75SP	0.67 lb	24	14
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Use of product may result in mite outbreak. Highly toxic to honey bees; do not apply when bees are present.			

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

GARDEN SYMPHYLANS (12/08)

Scientific Name: *Scutigerella immaculata*

DESCRIPTION OF THE PESTS

Garden symphylans, also called garden centipedes, are slender, white arthropods, closely related to insects, about 0.33 inch (8 mm long), with 10 to 12 prolegs and distinct antennae. These fast-moving arthropods live in soil and move up and down in the soil profile in relation to the moisture gradient. After an irrigation they are near the soil surface. As the soil dries, they move deeper. They hide when exposed to light. They occur mainly in soil with high organic matter and especially in organic farms that fertilize with manures. Symphylans are long lived; some adults may live several years. They move long distances in the soil profile (up to 3 feet below the soil surface), yet cannot tunnel through soil but must rely on existing soil pores. They do not thrive in either compact soil or sandy soils because these soils do not provide them with adequate tunnels for their movement.

DAMAGE

Garden symphylans feed on decaying as well as living plant material. They may damage seedlings (before or after emergence) or older plants. They slow growth by feeding on root hairs and small roots and feeding damage on older roots may provide entryways for pathogens. Damage usually is concentrated in relatively small areas and recurs every season; infestations spread slowly.

MANAGEMENT

This pest usually occurs in relatively small areas and in soils with a high organic matter. Reduce organic content and monitor known trouble spots to determine the need for spot treatments.

Cultural Control

Reduce the amount of undecomposed plant material or manure that is applied to the soil. Wait to seed until soil-incorporated weeds or manure has been broken down. Planting a higher seed population in problem areas may help compensate for damage.

Organically Acceptable Methods

Cultural control is an organically acceptable management tool.

Monitoring and Treatment Decisions

Research from other areas of the country indicates that symphylans can be detected with bait trapping. Either carrots or potatoes can be used as bait. Cut the bait in half longitudinally and scratch the cut surface just before placing it on the soil to ensure that the surface is moist. Place the bait at a depth where the soil is moist, and cover it with a plastic cup to exclude light and prevent the soil from drying. Use at least a dozen bait traps in the field. After 2 to 5 days, examine the cut surface and the soil upon which it was resting for evidence of symphylans. If they are detected, consider a treatment. If large numbers are detected (more than 20 per bait station), consider planting the field to a different crop.

Infested soil can be treated with an insecticide, but its effect is limited because of the symphylan's ability to migrate deep into the soil. Insecticides may help in giving the plants a chance to establish in a protected zone. Treat for symphylans just before planting. Spot treatments may be adequate.

Common name (trade name)	Amount/Acre**	R.E.I+ (hours)	P.H.I.+ (days)

The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact.

A. LAMBDA-CYHALOTHRIN*
(Warrior with Zeon) 3.2 fl oz 24 see comments
MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: PHI is 7 days for succulent shelled or edible podded crops and 21 days for dried shelled crops.

Common name (trade name)	Amount/Acre**	R.E.I+ (hours)	P.H.I.+ (days)
B. CYFLUTHRIN*			
(Baythroid)	Label rates	12	7
(Renounce) 20WP	Label rates	12	7
MODE OF ACTION GROUP NUMBER[1]: 3			

** See label for dilution rates.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment until harvest can take place. In some cases the R.E.I. exceeds the P.H.I. The longer of these two intervals is the minimum time that must elapse before harvest may take place.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

LEAFMINERS (12/08)

Scientific Names: *Liriomyza sativae* and *Liriomyza trifolii*

DESCRIPTION OF THE PESTS

Leafminer adults are very small flies, 0.1 inch (2.5 mm) long, black to blue, with parts of the thorax, legs, and abdomen yellow. Usually there is a prominent yellow area at the base of the wings. The minute white eggs are laid just under the leaf epidermis and hatch in 4 to 6 days. Maggots are normally concealed between leaf surfaces in the mines where they feed; they range from yellow to white, are 0.25 to 0.33 inch long, blunt at the rear end, and pointed in front. Pupation occurs in the mines or in the ground. During summer, the life cycle requires about 23 days. There are from three to five generations a year.

DAMAGE

Leafminers are occasionally a problem in beans generally during the latter part of the production season. The maggots feed between the upper and lower leaf surfaces causing large whitish blotches, or in the case of serpentine leafminers, slender, white, winding trails through the interior of the leaf.

MANAGEMENT

Biological Control Because of numerous common parasites, leafminers are generally not serious pests, but can be sporadic in their damage. The destruction of beneficial insects by frequent applications of insecticides applied to control other pests can result in leafminer outbreaks. Of the numerous parasites that attack leafminers in California, the most abundant is the parasitic eulophid wasp, *Solenotus intermedius*, but *Diglyphus* spp. and *Chrysocharis* spp. are probably the most important for controlling leafminers.

Organically Acceptable Methods Biological control and sprays of the Entrust formulation of spinosad are organically acceptable.

Monitoring and Treatment Decisions

To check for leafminers, evaluate the amount of mining in the leaves during weekly observations for other insect pests beginning at crop emergence. Continue to monitor leaves during vegetative growth, flower bud to bloom, and pod fill periods. Economic thresholds have not been determined on all bean varieties. On pinks and kidneys, treat if 25% of the surface of older leaves is mined and mines are present in the new leaves.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.			
A. SPINOSAD			
(Entrust)#	1.5–2 oz	4	28
(Success)	4.5–6 oz	4	28
MODE OF ACTION GROUP NUMBER[1]: 5			
COMMENTS: Do not apply more than 12 oz/acre/season of Success or 3.75 oz/acre/season of Entrust. For blackeyes, be sure to apply with an oil.			
B. CYROMAZINE			
(Trigard)	2.66	12	7
MODE OF ACTION GROUP NUMBER[1]: 17			
COMMENTS: Not for use on cowpeas.			

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

LOOPERS (12/08)

Scientific Names: Alfalfa looper: *Autographa californica*
Cabbage looper: *Trichoplusia ni*

DESCRIPTION OF THE PESTS

Alfalfa looper and cabbage looper larvae are green with three pairs of true legs up front and two pairs of robust, unjointed prolegs on the abdomen (back portion of the body). A distinguishing characteristic is that the larvae arch their backs when they crawl. Adults moths have dark brown, mottled forewings with a characteristic figure-eight marking in the center.

DAMAGE

Loopers may occur at any time during the growing season. Infestations early in the season on seedling plants may result in damage to cotyledons, new leaves, and terminal buds. Looper eggs are deposited singly, usually on the underside of younger leaves, and the larvae feed on larger, more mature leaves.

MANAGEMENT

Biological Control

Loopers have many natural enemies that frequently keep them below economic levels, unless they are killed by insecticide applications applied for other pests. Important parasitic wasps include the tiny egg parasite, *Trichogramma pretiosum*, and four wasps that attack the caterpillars: *Hyposoter exiguae*, *Copidosoma truncatellum*, *Microplitis brassicae*, and *Cotesia medicaginis* (alfalfa looper only). The tachinid fly, *Voria ruralis*, also attacks the caterpillar. In some areas, the nuclear polyhedrosis virus, an important biological control agent, occurs naturally in fields and kills loopers that it infects.

Organically Acceptable Methods Biological control and sprays of *Bacillus thuringiensis* and the Entrust formulation of spinosad are organically acceptable.

Monitoring and Treatment Decisions

Start inspecting plants for looper damage along with other pests and their damage during the vegetative growth period. Continue monitoring from flower bud to bloom and during the pod fill period. Specific treatment thresholds have not been established for these foliage feeders. Late-season infestations are insignificant. If damaging numbers are encountered mid-season when excessive foliage loss may reduce crop production, a treatment may be warranted.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. BACILLUS THURINGIENSIS ssp. AIZAWAI#

(various products)	Label rates	4	0

MODE OF ACTION GROUP NUMBER[1]: 11.B1
COMMENTS: This material does not destroy natural enemies of corn earworm. Control is maximized by thorough coverage and by making applications when larvae are small.

B. SPINOSAD

(Entrust)#	1.25–2 oz	4	28
(Success)	4–6 fl oz	4	28

MODE OF ACTION GROUP NUMBER[1]: 5
COMMENTS: Do not apply more than 12 oz/acre/season of Success or 3.75 oz/acre/season of Entrust. For blackeyes, be sure to apply with an oil.

C. SPINETORAM

(Radiant) SC	4-8 fl oz	4	28

MODE OF ACTION GROUP NUMBER[1]: 5

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
D. CARBARYL*			
(Sevin) 80S	1.25 lb	12	see comments
(Sevin) XLR Plus	1 qt	12	see comments
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: May result in outbreak of spider mites. Do not use on lentils in California. XLR Plus formulation is the least toxic to honey bees when direct application to bees is avoided and the spray residues have dried. Apply from late evening to early morning when bees are not foraging. Do not apply within 14 days of grazing or harvest for forage, within 3 days of harvest of fresh beans or peas, and within 21 days of harvest of dried beans, peas, seed, or hay.			
E. ACEPHATE			
(Orthene) 75 SP	0.67 lb	24	14
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: Use of product may result in mite outbreak. Highly toxic to honey bees; do not apply when bees are present.			
F. METHOMYL*			
(Lannate SP)	0.5–1 lb	48	14
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Highly toxic to honey bees; do not apply when bees are present. Do not apply more than 4.5 lb a.i./acre/crop.			
G. LAMBDA-CYHALOTHRIN*			
(Warrior with Zeon)	3.84 oz	24	see comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: May cause outbreaks of mites. Preharvest interval (P.H.I.) is 7 days for succulent shelled or edible podded crops and 21 days for dried shelled crops.			
H. ZETA-CYPERMETHRIN*			
(Mustang)	4.3 oz	12	see comments
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: May cause outbreaks of mites. Preharvest interval (P.H.I.) is 1 day for succulent shelled or edible podded crops and 21 days for dried shelled crops.			

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

LYGUS BUGS (12/08)

Scientific Names: *Lygus hesperus*, *Lygus elisus*

DESCRIPTION OF THE PESTS

The lygus bug adult is about 0.25 inch long and about half as wide. It is generally brownish but varies from green to straw-colored, tawny, or light brown; the body is marked with a pattern of different shades of brown and occasionally yellow or red marks. A prominent V-shaped yellowish area is near the center of the body at the base of the wings.

Lygus eggs are laid within plant tissue so that only the oval-shaped cap is visible. These eggs are hard to locate, even with the use of a hand lens. Active green nymphs hatch from the eggs. Red coloration on the tips of the antennae helps to distinguish early instar Lygus from aphids. Older nymphs may be recognized by distinct wing pads and by the five black dots on their backs, two on the first and second segments of the thorax and one in the center of the abdomen.

DAMAGE

Lygus bugs may be present throughout the growing season and can be highly destructive to a bean crop. They have sucking mouthparts with which they pierce and consume plant tissue. The type of damage varies with plant age. During early bud and flowering stages, lygus bugs cause bud and flower loss resulting in reduced yields. Lygus bug feeding on young, developing seed pods causes pod distortion, pitting, blemishes on table market beans, and reduce germination in seed beans.

MANAGEMENT

Biological Control Lygus bug eggs are often parasitized and killed by a small parasitic wasp, *Anaphes iole*. General predators, such as lacewings and damsel bugs, may prey on lygus bug nymphs. Minimizing the use of broad-spectrum insecticides will help conserve these natural enemies.

Cultural Control Lygus are likely to move when weeds such as pigweed, wild radish, and mustard dry and become unsuitable. Lygus are also known to migrate from newly cut alfalfa fields and safflower fields to nearby crops, where they cause considerable damage.

As a preferred host, alfalfa hay might be managed to suppress movement of lygus into dry bean fields by staggering cuttings to preserve habitat. Leave a small, uncut strip at each harvest to help limit the movement of lygus bugs into neighboring beans. The use of habitat preservation does not work as well in beans as in cotton because lygus prefers legumes as a habitat. However, alfalfa strips also serve as reservoirs for predators and parasites that will eventually move into beans and help suppress spider mites, lygus bugs, and caterpillars. If considering the use of alfalfa habitat preservation (strip or staggered cutting), be aware of the potential for quick movement and establishment in beans by lygus.

Overall Strategy Maintain nearby alfalfa fields in a succulent condition.

- Avoid cutting all alfalfa fields in an area within a short time period. Leave an uncut strip or check at each cutting along the border between alfalfa and beans to slow lygus bug migration.
- If lygus bug populations get very high, uncut strips of alfalfa may be treated with an insecticide if needed, but sprays should be avoided where possible to protect beneficials.
- Where strips of alfalfa grow within or along edges of the bean field:
    - Plant a sufficient area with alfalfa, manage for succulent growth, and alternate cutting half of each strip every two weeks.
    - Cut back alfalfa stems with a stalk cutter. In a 28-day cycle, many lygus bug eggs will be inside the cut stems and will die as the stems desiccate.

Lygus populations can impact vine and bush varieties of baby and large limas differently. In research trials, bush variety Luna showed better lygus tolerance and higher yields than other varieties. Yields were not affected up to 1.5 lygus/sweep with Luna variety at the bud through flowering stage. (This variety does not have nematode resistance, however, and should not be used in fields with a history of nematode populations). Baby lima varieties UC 302 and UC 279 look promising in resistance to lygus bug but have not yet been released.

Organically Acceptable Methods

Biological and cultural control are organically acceptable methods.

Monitoring and Treatment Decisions
Start sampling during the bud stage and continue through pod fill. Check fields twice weekly. Record observations on a monitoring form (*example available online*). Determine lygus bug numbers (adults and nymphs) by using the standard insect sweep net. Take a series of five to ten 180° sweeps in four to six areas of the field. Pass the net through the top of two rows of bean plants (one bed for double row plantings or two beds for single row plantings). Treatment thresholds are available for bean yield; however, these thresholds may not reflect losses in bean quality. Treatment thresholds are:

Blackeyes: 0.5 lygus bug per sweep during bud through small pod stage; 1.0 bug per sweep later in season.

Baby Limas: Luna variety 1.0 to 1.5 lygus per sweep from bloom to flowering; 1.5 to 2.0 per sweep later in season.

Limas, all other varieties: 0.5 lygus bug per sweep during early bloom; 1.0 to 2.0 bugs per sweep later in season.

Common beans: 1.0 to 1.5 bugs per sweep.

Note: Determining lygus populations in vine type varieties is difficult because of the large amount of plant biomass that makes it impossible to penetrate into the canopy with a sweep net. Pulling the canopy apart and visually inspecting for lygus activity is highly recommended along with sweeping. Mid-morning evaluations are more accurate than afternoon evaluations because hot temperatures cause lygus to retreat into the lower sections of the canopy.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.			
A. LAMBDA-CYHALOTHRIN* (Warrior with Zeon)	2.56–3.84 oz	24	see comment
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Do not apply more than 0.96 pt/acre/season. Has some mite suppressive activity but may not prevent an outbreak. Preharvest interval (P.H.I.) is 7 days for succulent shelled or edible podded crops and 21 days for dried shelled crops.			
B. ZETA-CYPERMETHRIN* (Mustang)	3–4.3 oz	12	see comment
MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Can cause outbreaks of bean aphid and mites. Tank mix with dimethoate if bean aphid is present. If mites are present, consider a tank mix with dicofol (Kelthane). (For all tank mixes, observe all directions for use on both labels, and employ the most restrictive limits and precautions.) Do not apply more than 0.3 lb a.i./acre/season. Preharvest interval (P.H.I.) is 1 day for succulent shelled or edible podded crops and 21 days for dried shelled crops.			
C. DIMETHOATE 2.67 lb/gal EC	1.5 pt	48	0
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: May result in mite outbreak. Highly toxic to honey bees; do not apply when bees are present. Ground or air application. Do not feed treated vines to livestock. Lygus bug populations may be resistant to dimethoate in some areas.			
D. ACEPHATE (Orthene) 75 SP	0.67 lb	24	14
MODE OF ACTION GROUP NUMBER[1]: 1B			
COMMENTS: May result in mite outbreaks. Highly toxic to honey bees; do not apply when bees are present. Ground or air application. Do not feed treated vines to livestock.			

** Mix with sufficient water to obtain full coverage.
+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
* Permit required from county agricultural commissioner for purchase or use.
1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action

Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

SALTMARSH CATERPILLAR (12/08)

Scientific Name: *Estigmene acrea*

DESCRIPTION OF THE PEST

The saltmarsh caterpillar is most abundant in August and September, but damaging populations are sporadic. Eggs are spherical, whitish, somewhat flattened, about 3/100 inch (0.75 mm) in diameter, and found in naked clusters on the undersurface of leaves. Young larvae are hairy and gray when first hatched, then darken to yellow, brownish, or almost black with yellow lines. They are covered with reddish or black hairs and can be up to 2 inches long when fully grown. Young larvae feed in groups, but as they grow they disperse and start feeding individually.

DAMAGE

Damage by saltmarsh caterpillar consists primarily of defoliation.

MANAGEMENT

Start inspecting plants for saltmarsh caterpillar damage along with other pests and their damage during the vegetative growth stage; continue to monitor these caterpillars from bud to blossom and during the pod fill period. Specific treatment thresholds have not been established for these foliage feeders. Late-season infestations are insignificant. If damaging numbers are encountered mid-season when excessive foliage loss may reduce crop production, a treatment may be warranted.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. BACILLUS THURINGIENSIS ssp. KURSTAKI#
(various products) Label rates 4 0
MODE OF ACTION GROUP NUMBER[1]: 11.B2
COMMENTS: Does not destroy natural enemies of corn earworm. Control is maximized by thorough coverage and by making applications when larvae are small.

B. ACEPHATE
(Orthene) 75 SP 0.67 lb 24 14
MODE OF ACTION GROUP NUMBER[1]: 1B
COMMENTS: Use of product may result in mite outbreak. Highly toxic to honey bees; do not apply when bees are present.

C. METHOMYL*
(Lannate SP) 0.5–1 lb 48 14
MODE OF ACTION GROUP NUMBER[1]: 1A
COMMENTS: Highly toxic to honey bees; do not apply when bees are present. Do not apply more than 4.5 lb a.i./acre/crop.

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

[1] Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

SEEDCORN MAGGOT (12/08)

Scientific Name*: Delia platura*

DESCRIPTION OF THE PEST

The seedcorn maggot adult is a slender, light gray fly, about 0.20 inch (5 mm) long; it is less robust appearing than the housefly. The whitish eggs are slightly curved with their posterior bluntly rounded. Slightly raised ridges run the length and width of the eggs forming tiny rectangles twice as long as wide. Larvae range from 0.20 to 0.25 inch (5 to 6 mm) in length, are white to whitish yellow, cylindrical, and taper anteriorly. Pupae are small brown capsules. The seedcorn maggot is abundant during or following a wet cycle, which is primarily in spring, and is most common in fields containing a high amount of residue from a previous crop or where manure has been spread.

DAMAGE

Seedcorn maggots burrow into bean seeds and prevent germination. Slow emergence and poor stand establishment are signs of seedcorn maggot activity. Where slow, spotty emergence is observed, seed should be dug up and inspected for maggot feeding. Soil and weather conditions such as cool soil temperature and periods of excessive moisture favoring slow seed germination and seedling emergence increase susceptibility to seedcorn maggot infestation.

MANAGEMENT

Cultural Control

To reduce attractiveness of the field to egg-laying adults, disc or plow early in the season incorporating residues from a previous crop and destroying weed growth. Plant under ideal soil and weather conditions to assure rapid seed germination and minimize the seedcorn maggot problem.

Organically Acceptable Methods Cultural control is acceptable in an organically certified crop.

Treatment Decisions Begin inspecting plants for seedcorn maggot damage along with other pests and their damage when the crop emerges. Because a preventive seed treatment is the best method of control, note any signs of an infestation so that treated seed can be used in the future. Check with your local farm advisor about current registrations.

SILVERLEAF WHITEFLY (12/08)

Scientific Name: *Bemisia argentifolii*

DESCRIPTION OF THE PEST

Silverleaf whiteflies are small insects about 0.06 inch long. The body and wings of adults are covered with a fine, whitish powdery wax, opaque in appearance. Whiteflies colonize on the underside of leaves. Adults and eggs are commonly found on the lower surface of younger leaves, and the scalelike nymphal stages on somewhat older leaves. Clouds of small white insects fly up when plants are disturbed.

DAMAGE

Silverleaf whiteflies generally are not a serious problem in beans. When present, infestations are frequently restricted to small areas and to the field edge. Infested leaves will be slightly curled and copious quantities of honeydew may be deposited on leaves, resulting in a sticky, shiny appearance.

MANAGEMENT

Biological Control Several wasps, including species in the *Encarsia* and *Eretmocerus* genera parasitize whiteflies. Whitefly nymphs are also preyed upon by bigeyed bugs, lacewing larvae, and lady beetles. Silverleaf whitefly is an introduced pest that has escaped its natural enemies. Some indigenous native parasites and predators do attack it, but do not keep it below damaging numbers.

Organically Acceptable Methods Biological control is organically acceptable.

Treatment Decisions Chemical treatments are not recommended for silverleaf whitefly on dry beans.

SPIDER MITES (10/10)

Scientific Names: Twospotted spider mite: *Tetranychus urticae*
Strawberry spider mite: *Tetranychus turkestani*
Pacific spider mite: *Tetranychus pacificus*

DESCRIPTION OF THE PESTS

The most common spider mites encountered on beans is the twospotted spider mite, but the strawberry spider mite and Pacific spider mite can also be found in this crop. Infestations may include a mixture of spider mite species. Adult mites are nearly microscopic, have four pairs of legs, are greenish to pink or cream colored, and have various sized black spots on the body. Under warm conditions spider mites move rapidly within the colony area. Spider mites have four stages of development: (1) the oval, somewhat translucent egg; (2) a six-legged translucent larval stage; (3) an eight-legged nymphal stage; and (4) the eight-legged adult stage. A resting or quiescent stage occurs at the end of the larval and nymphal stages. A generation may pass in as few as 5 to 7 days in mid-summer, or in a month during cool periods.

DAMAGE

All active stages of spider mites damage beans by piercing individual plant cells and removing the contents, sucking juices from infested leaves and pods. Damaged leaves become somewhat stippled on the upper surface and grayish because of webbing and feeding on the undersurface. Spider mites are most serious on lima beans and common dry beans, but can cause problems in blackeyes, especially on field edges near roads and after treatment for lygus bug.

MANAGEMENT

Cultural and Biological Control Reduce spider mite problems by keeping fields, field margins, and irrigation ditches clean of weed hosts such as field bindweed and lambsquarter. Spider mite populations may also increase more rapidly in areas where dust deposits are heavy on bean plants. Thus, reducing dust may reduce the spider mite problem. Spider mites are usually less severe in sprinkler-irrigated fields than in furrow-irrigated fields. Spider mite populations do not develop on blackeyes as rapidly as they do on limas, kidneys, and small whites. Spider mite populations may be held at very low levels by a number of insect and mite predators, particularly early in the season. Sixspotted thrips are effective early season predators, feeding primarily on spider mite eggs. Spider mites provide an important food source for predators such as minute pirate and bigeyed bugs. Minimizing early season insecticide applications to help conserve beneficials will reduce spider mite outbreaks.

Organically Acceptable Methods Cultural and biological control are organically acceptable.

Monitoring and Treatment Decisions

There is no precise survey technique for evaluating spider mite infestations. Infestations usually begin on the lower portions of the plants and move upward as mite numbers increase. Start inspecting plants for spider mite damage along with other pests and their damage during the vegetative growth stage. Continue looking for mites from the flower bud to bloom period and during the pod fill period. Evaluating spider mite infestations is most efficient if randomly selected, older, lower leaves are picked and inspected for stippling on the upper surface and webbing, mites, and feeding scars on the lower surface. If spider mites can be found easily on older leaves at early bloom before the first insecticide application for lygus bug control, it would be advisable to use an acaricide at the time of the first treatment for lygus bug control.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A.	BIFENAZATE (Acramite 4SC)	16–24 fl oz	12	3
	MODE OF ACTION GROUP NUMBER[1]: unknown or uncharacterized			

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
B. DICOFOL			
(Dicofol 4E)	3 pt	12	21
MODE OF ACTION GROUP NUMBER[1]: 20			
COMMENTS: Ground application preferred. Spider mite populations in some areas may be resistant. Do not feed treated vines to meat or dairy animals.			
C. PROPARGITE*			
(Comite)	32–48 fl oz	216 (9 days)	14
MODE OF ACTION GROUP NUMBER[1]: 12C			
COMMENTS: Do not use on fresh market pod varieties. Do not feed or forage treated vines or trash after harvesting.			
D. ALDICARB*			
(Temik) 15% Granules	7 lb (35-inch row spacing)	48	90
MODE OF ACTION GROUP NUMBER[1]: 1A			
COMMENTS: For dry beans at planting. Not widely recommended but may be warranted in the southern San Joaquin Valley on cowpeas. Drill aldicarb granules 2–3 inches below seed line or 2 or 3 inches to the side of the row and 2–3 inches deep. Granules may be placed in the seed furrow if the rate does not exceed 5 lb/acre. Do not make more than one application per season. Do not feed treated forage, hay, or straw to livestock or use green pods for human food. Aldicarb will usually also reduce lygus populations through early bloom but will not prevent damage later in the season. Do not apply in Del Norte and Humboldt counties.			

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

* Permit required from county agricultural commissioner for purchase or use.

STINK BUGS (12/08)

Scientific Names: Consperse stink bug: *Euschistus conspersus* and others

DESCRIPTION OF THE PESTS

Adult stink bugs are shield shaped, from 0.38 to over 0.5 inch in length and are more than half as wide. Body color ranges from green to grayish brown to dark chocolate. Eggs are small, white to pinkish or greenish, barrel shaped, and are deposited on the foliage in clusters. Nymphs are oval to shield shaped and vary widely in color.

DAMAGE

Stink bugs have piercing-sucking mouthparts and cause damage similar to that of lygus bugs. During the early bud and bloom stages, stink bugs cause bud and flower loss, resulting in reduced yields. Stink bugs also feed on the young developing seed pods causing pod distortion, as well as pitting and blemishes on table market beans, and reduced germination in seed beans. Unlike lygus, stink bugs are capable of feeding on mature beans.

MANAGEMENT

Biological Control

A complex of native and introduced parasitic wasps attack stink bug egg masses in dry beans. Eggs turn black when parasitized by these wasps with up to 80% parasitism in some species such as the southern green stink bug. The incidence of parasitized eggs should be considered when making management decisions.

Organically Acceptable Methods Biological control is organically acceptable.

Monitoring and Treatment Decisions

Start sweeping or beating for stink bugs at bloom and continue through pod fill. Sweeping will give a clue as to the presence of a stink bug population. If an occasional stink bug is picked up while sweeping for lygus, stink bugs should be more closely evaluated. However, beating or shaking the plants over pans, sleds, or sheets placed in furrows is a more effective survey method for stink bugs. Stink bugs may migrate into dry bean fields following harvest of nearby tomato fields. Treat if stink bugs are consistently found during checking and the field still contains small pods.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact.

A. LAMBDA-CYHALOTHRIN*
(Warrior with Zeon) 3.84 oz 24 see comments
MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: May cause outbreaks of mites. Preharvest interval (P.H.I.) is 7 days for succulent shelled or edible podded crops and 21 days for dried shelled crops.

B. ZETA-CYPERMETHRIN*
(Mustang) 4.3 oz 12 see comments
MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: May cause outbreaks of mites. Preharvest interval (P.H.I.) is 1 day for succulent shelled or edible podded crops and 21 days for dried shelled crops.

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

THRIPS (8/07)

Scientific Name: *Frankliniella occidentalis* and others

DESCRIPTION OF THE PESTS

Thrips are small insects, about 0.04 inch long. Adult thrips have two pairs of narrow wings which are fringed with hairs. Immature thrips are wingless, whitish to yellowish in color, and are most commonly found in buds, flowers, or on the underside of leaves. Adults emerge continuously throughout the warm months. Adults and immatures may be found in beans at any time during the growing season. Eggs are deposited in plant tissue and hatching occurs in about 5 days during the summer months; the immature stages take about 5 to 7 days to complete development.

DAMAGE

Thrips are most noticeable and of greatest concern on young seedling plants. Their feeding will make the plants look ragged because they feed on young leaves and buds. A common sign of a heavy thrips infestation is distorted leaves that turn brownish around the edges and cup upward. Usually the plants will grow away from the problem, just as they outgrow severe ragging resulting from wind damage. Foliage-feeding thrips are effective predators on early season spider mite infestations. Both adult and immature thrips may be found in spider mite colonies feeding on spider mite eggs.

MANAGEMENT

Biological control and unfavorable weather generally reduce thrips populations before treatment is necessary and plants usually recover from thrips injury.

Biological Control Minute pirate bugs (*Orius tristicolor*) play a major role in controlling thrips populations.

Cultural Control Thrips populations tend to build up on weeds. Cultivating nearby weedy areas before beans emerge will reduce the potential of a thrips problem when the weeds begin to dry out. Cultivating weedy areas after bean emergence will increase thrips problems.

WEEVILS (12/08)

Scientific Names: Cowpea weevil: *Callosobruchus maculatus*
Broad bean weevil: *Bruchus rufimanus*
Bean weevil: *Acanthoscelides obtectus*

DESCRIPTION OF THE PESTS

The adults are relatively small beetles, 0.13 to 0.2 inch (3.5 to 5 mm) in length, somewhat teardrop or triangular in shape, and dull-colored with white, reddish, or black markings. The eggs may be glued to the bean or the pod (cowpea weevil), glued to green pods (broad bean weevil), or laid loosely among beans or through cracks in the pods (bean weevil). The larval and pupal stages are spent inside the bean. The cowpea weevil is perhaps the most common of the weevils in California. Infestations can begin in the field. Adults move to bean fields from trash beans left in sacks, harvesters, planters, or feed areas. The cowpea weevil readily attacks dried beans; thus this weevil can be a serious storage pest.

Bean weevil infestations can also start in the field and may also originate from trash beans. As with the cowpea weevil, bean weevil will attack dried beans and can be a serious pest in stored beans. Broad bean weevil infestations also start in the field, but this pest is not a storage problem.

DAMAGE

The larval stage of the weevil pests of dry beans tunnel and develop within the beans. They may consume nearly the entire bean contents. Pupation occurs in the beans and adults emerge through a round hole in the seed coat. Damage is a combination of the feeding and contamination.

MANAGEMENT

Sanitation offers the most practical means of control. Because field infestations originate from beans, eliminate potential sources of weevils in production areas. Potential sources of weevils include broken sacks of seed beans left over from planting; seed beans left in planting hoppers; cull beans used in animal feed programs in a production area; small collections of beans remaining on or in a harvester following harvest; and small piles of beans remaining in or around the field after harvest or in a warehouse area.

Monitoring and Treatment Decisions

Field survey methods have not been developed, and insecticide applications during the production season have not provided effective control. Fumigation of beans at the warehouse site is imperative when infested beans are being brought in from the field. Fumigants are registered for this use. Fumigation of cull beans that are known to be infested may be desirable before releasing the culls for animal feed within a production area.

WIREWORMS (12/08)

Scientific Name: *Limonius* spp. and others

DESCRIPTION OF THE PESTS

Wireworms are the soil-dwelling larvae of the click beetle. They are shiny, slender, cylindrical, hard-bodied, wirelike, yellow-to-brown larvae found at all times of the year and in almost any kind of soil. The larval (or wireworm) stage of this beetle may last several years.

DAMAGE

Wireworm larvae injure crops by devouring seeds in the soil, thus preventing seedlings from emerging. They also cause damage by cutting off small, underground stems and roots; and by boring in larger stems and roots.

MANAGEMENT

Wireworms may be a problem following an alfalfa rotation or in fields that were previously pastures. Cultivating, flooding, and dry fallowing can help reduce populations.

The presence of wireworm larvae can be monitored by burying carrot pieces partially into the soil at seeding to attract the wireworms. If wireworms are present, a preventive seed treatment may be necessary.

Start inspecting plants for wireworm damage along with other pests and their damage when the crop emerges. Often the wireworm will be found near the damaged or missing seed or plant. Consider using treated seed in fields with a history of wireworm problems.

Common name (trade name)	Amount/Acre**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to natural enemies and honey bees and environmental impact.			
A. IMIDACLOPRID (Admire Pro)	7–10.5 fl oz	12	21
MODE OF ACTION GROUP NUMBER[1]: 4A COMMENTS: A soil application, may also be applied in irrigation water. Apply before or at planting when monitoring suggest wireworms could be a problem.			

** See label for dilution rates.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment until harvest can take place. In some cases the R.E.I. exceeds the P.H.I. The longer of these two intervals is the minimum time that must elapse before harvest may take place.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

Diseases

ALFALFA MOSAIC (Yellow Dot) (8/07)

Pathogen: *Alfalfa mosaic virus* (AMV)

SYMPTOMS

Symptoms of alfalfa mosaic in beans vary depending on the strain of the virus. Some strains cause only localized symptoms that may include necrotic spots on infected leaves. Other strains infect the entire plant and cause symptoms ranging from yellow dots to a striking yellow mottle, which may be accompanied by leaf and pod distortion and stunted plant growth.

COMMENTS ON THE DISEASE

Alfalfa mosaic virus has a wide host range and is transmitted from plant to plant by various aphids. Alfalfa is an important perennial host for alfalfa mosaic.

MANAGEMENT

Alfalfa mosaic is a minor disease of beans in California and warrants no control measures. Growers should plant certified seed and may want to avoid planting bean fields adjacent to alfalfa fields.

ASCOCHYTA BLIGHT (Garbanzo Beans) (12/08)

Pathogen: *Ascochyta rabiei, Didymella rabiei*

SYMPTOMS

Ascochyta blight is a serious disease of garbanzo beans. Symptoms develop on all aerial parts of the plant at any stage of growth.

On seedlings, brown lesions that develop at the base of the stem may lead to damping-off like symptoms.

During or after cool, rainy weather, foliar symptoms first appear on leaves as circular light brown lesions with no margins. As the lesions continue to develop small, black, raised spots (pycnidia) form in concentric circles within the lesions and are a good diagnostic characteristic of the disease.

Dark brown stem lesions weaken the stem, which often breaks. Lesions on pods are similar to those on leaves and result in poor seed set. Pod infection may also lead to discoloration and shrinkage of the seed. Developing beans can become infected and, if used for seed, can lead to early infections in the next crop. Overall, severe infections lead to general plant blight.

COMMENTS ON THE DISEASE

The fungus overwinters on infected garbanzo debris left in the field or in or on seed. During wet weather, spores are released from pycnidia and are splashed or carried in rain or irrigation water. (This is the asexual spore stage that has been identified as *Ascochyta rabiei*.) Once plants become infected, new spores are formed that spread to adjacent plants, creating expanding areas of diseased plants in fields. Symptoms develop 3 to 6 days after infection; moderate temperatures (68° to 77°F) and wet weather are optimum for severe disease.

Another type of fruiting body, pseudothecia, may develop when both compatible mating types of the fungus are present. Spores produced in pseudothecia are airborne and may play an important role in long-distance dispersal of the pathogen but are not important in local and short-term disease development. This is the sexual spore stage, which is identified as *Didymella rabiei*.

MANAGEMENT

The use of tolerant cultivars is one of the most effective and economical disease management practices. However, because more than one *Ascochyta* mating type has been identified, host plant resistance/tolerance to the disease is good for a limited number of growing seasons. Currently available public and private varieties with tolerance to most or all mating types identified in California include Sierra, Dylan, HB-14, Sutter, San Joaquin, and recent releases of the Airway Farms (AWF) series.

In susceptible varieties, cultural practices can be effective in managing this disease. Always use clean seed, rotate away from garbanzos, and thoroughly incorporate infested garbanzo residue. Crop rotation of 2 to 3 years will eliminate inoculum in the soil because the fungus won't survive in the absence of garbanzo host tissue. Wide row and plant spacing may increase ventilation between plants and reduce favorable conditions for plant infection.

Always plant seed that has been treated. Foliar applications of fungicides limit the rate of disease spread. Apply fungicides at first sign of disease and re-apply according to the label if rainy weather is forecasted. Thorough coverage of the plant canopy is important.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing a pesticide, consider information relating to environmental quality.

SEED TREATMENTS

A. THIABENDAZOLE
(Mertect) 340-F 2.04 fl oz/100 lb seed
MODE OF ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)
COMMENTS: Use allowed under a 24(c) registration.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
FOLIAR APPLICATIONS			
A. CHLOROTHALONIL (Bravo WeatherStik)	1.36-2 pt	12	14
MODE OF ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
COMMENTS: A protectant. Apply at first sign of disease before rain or sprinkler irrigation.			
B. PYRACLOSTROBIN (Headline)	6-9 fl oz	12	21
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Apply before or within 36 hours of a rain.			
C. AZOXYSTROBIN (Quadris)	6-15.5 fl oz	4	14
MODE OF ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
COMMENTS: Apply before or within 36 hours of a rain.			
D. BOSCALID (Endura)	8–11 oz	12	21
MODE OF ACTION GROUP NAME (NUMBER[1]): Carboxamide (7)			
COMMENTS: Apply before or within 36 hours of a rain.			

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode of action Group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode of action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode of action Group number.

BACTERIAL BROWN SPOT (8/07)

Pathogen: *Pseudomonas syringae* pv. *syringae*

SYMPTOMS

Bacterial brown spot symptoms on leaves appear as oval spots that have dead (necrotic) tissue in the center surrounded by a narrow zone of light-green to yellow tissue. Water-soaking and slimy ooze is rarely seen with this disease. The spots may grow together and the centers of the spots often fall out, resulting in an overall tattered appearance of the leaf. On pods, small dark brown spots develop that result in distorted pod growth.

COMMENTS ON THE DISEASE

Bacterial brown spot occurs sporadically and rarely in California. It is readily distinguished from the more serious common and halo blights based on leaf symptoms.

MANAGEMENT

Control is similar to that for common and halo blights: plant certified bean seed, rotate crops, and clean crop and other host debris from the field after harvest to help prevent outbreaks of brown spot.

BEAN ANTHRACNOSE (8/07)

Pathogen: *Colletotrichum lindemuthianum*

SYMPTOMS

The anthracnose fungus infects leaves, stems, and pods of common bean plants. The most characteristic symptom of the disease is the black-red sunken cankers or spots that develop on infected pods. As these spots become older, the edges develop a black ring with a red outer border and may show a pink ooze in the center, which contains the spores of the fklungus. Similar spots may develop on seeds. Red-brown spots and streaks also develop on stems, petioles, and leaves. A characteristic symptom of the disease occurs on the underside of infected leaves: veins turn brick-red to purple and eventually black.

COMMENTS ON THE DISEASE

Anthracnose develops under cool moist conditions, and thus is rarely a problem under California conditions. The fungus overwinters in bean debris in the field or in association with seed. Young beans are infected from spores carried on seed or spores splashed from debris or nearby infected plants. The spores are then spread throughout the field by machinery, wind driven rain, irrigation water, and animals.

MANAGEMENT

Plant certified seed grown in areas unfavorable for anthracnose (e.g., California or Idaho). Resistant varieties are available, and should be used if possible. Use furrow rather than sprinkler irrigation because of the importance of water for disease development. Bean debris in infected fields should be plowed under immediately after harvest. Because the fungus is primarily a pathogen of common bean (but also infects lima bean and scarlet runner bean) crop rotations of 2 to 3 years are effective.

BEAN COMMON MOSAIC (8/07)

Pathogens: *Bean common mosaic virus* (BCMV) and *Bean common mosaic necrotic virus* (BCMNV)

SYMPTOMS

There are two main types of symptoms associated with bean common mosaic disease: common mosaic and common mosaic necrosis. The occurrence of either type of symptom depends on the particular virus present and whether or not the bean cultivar possesses the dominant I resistance gene. If the cultivar has the dominant I gene, it is resistant to strains of the Bean common mosaic virus, but hypersensitive to strains of the Bean common mosaic necrosis virus.

Common mosaic symptoms. In California *Bean common mosaic virus* is the more prevalent of the two pathogens involved with this disease. When it infects susceptible cultivars, *Bean common mosaic virus* causes common mosaic symptoms that appear as a light green-yellow and dark green mosaic pattern developing on the trifoliolate leaves. (Often veins are dark green whereas the interveinal areas become light green-yellow.) Leaf discoloration is usually accompanied by puckering, blistering, distortion, and a downward curling and rolling. The intensity and severity of the symptoms depends on the strain of Bean common mosaic virus, the bean cultivar, and the age of the plant when infected. Plants infected at a young age may be stunted and distorted.

Common mosaic necrosis symptoms. Common mosaic necrosis symptoms are rare in California because the *Bean common mosaic necrosis virus* is not endemic. Necrosis symptoms only develop when the virus infects cultivars that possess the dominant I gene. The symptoms begin as small, red-brown spots that appear on primary or trifoliolate leaves shortly after the virus has been introduced via an aphid vector. The veins around these spots become brown-black, and this vein necrosis then spreads into the phloem tissue of the plant, causing first a wilting, and then death (necrosis) of young leaves and the meristem. The entire plant eventually dies. Cross sections of stems and pods reveals a red-brown streaking in the vascular tissue. These symptoms are often referred to as black root rot (not to be confused with the fungal disease black root rot caused by *Thielaviopsis basicola*). Common mosaic necrosis symptoms can be confused with those of Fusarium yellows caused by *Fusarium oxysporum* f. sp. *phaseoli*. However, necrosis in the vascular tissue of the pods, which is absent in plants having Fusarium yellows, is diagnostic of bean common mosaic necrosis disease.

In bean varieties that lack the I gene, *Bean common mosaic necrosis virus* induces common mosaic symptoms that are similar to those caused by *Bean common mosaic virus.* Certain other viruses can also cause necrosis symptoms in common bean. Thus, development of necrosis alone is not sufficient for a positive diagnosis of bean common mosaic necrosis disease, and additional tests must be performed.

COMMENTS ON THE DISEASE

Bean common mosaic virus is the most common and widespread virus of common bean because it is seed- and aphid-transmitted. *Bean common mosaic necrosis virus* strains were previously referred to as 'necrotic strains of *Bean common mosaic virus'* but it was found that the necrotic strains were actually a distinct virus species. Thus, these strains were given the name *Bean common mosaic necrosis virus.* As both *Bean common mosaic virus* and *Bean common mosaic necrosis virus* cause similar symptoms on varieties without the I gene, they are distinguished by their reaction on I gene-containing varieties or other tests, such as ELISA.

Bean common mosaic necrosis virus is considered to be endemic to Africa. It has been spread throughout the world in infected seeds of non-I gene varieties, and it has been introduced into Idaho, Michigan and New York. In California, *Bean common mosaic necrosis virus* was detected in a single bean field in 1996, and it has not been detected since.

Bean common mosaic virus and *Bean common mosaic necrosis virus* are members of the potyvirus family of plant viruses, and both are related to *Bean yellow mosaic virus* (BYMV) and *Clover yellow vein virus* (ClYVV), two other potyviruses that infect common bean in California. *Bean common mosaic virus* and *Bean common mosaic necrosis virus* are differentiated from *Bean yellow mosaic virus* and *Clover yellow vein virus* based on symptoms, host range, seed transmissibility, and antibody tests (e.g., ELISA). However, because the symptoms of these viruses can overlap in certain bean cultivars and mixed infections are not common, antibody tests (ELISA) are the most reliable method for identifying these viruses.

MANAGEMENT

Bean common mosaic disease in California can be effectively controlled through the planting of certified seed (e.g., seed certified by the California Crop Improvement Association, CCIA) and/or resistant varieties that contain the I gene or other *Bean common mosaic virus* resistance genes. There are now a number of well characterized *Bean common mosaic virus* resistance genes, and these have been or are presently being incorporated into commercial dry and snap bean varieties. Thus, it is important to know if a variety possesses *Bean common mosaic virus* resistance and, if so, which resistance gene(s). For varieties that are susceptible to this virus, the disease may be minimized by establishing fields in isolated areas (i.e., not near established bean fields or in areas with extensive bean production).

Because many bean cultivars grown in California possess the I gene for resistance to *Bean common mosaic virus,* it is imperative to prevent *Bean common mosaic necrosis virus* from becoming established in California. Bean common mosaic necrosis virus cannot be carried in seed of varieties that possess the I gene because of the necrosis reaction it causes in these varieties; it can only be carried on seed of non-I gene varieties. Therefore, the best way to keep it from becoming established in California is to minimize the planting of non-I gene seed from areas known to have *Bean common mosaic necrosis virus.*

BEAN YELLOW MOSAIC (8/07)

Pathogen: *Bean yellow mosaic potyvirus* (BYMV)

SYMPTOMS

The diagnostic symptom of bean yellow mosaic is the bright yellow to green mosaic or mottle appearance of infected leaves, which becomes most apparent on leaves as they become older. Infected leaves also show varying degrees of leaf distortion, down cupping, and wrinkling. Plants infected at a young age may show stunted growth. The striking yellow mosaic symptoms differentiate bean yellow mosaic infections from those of bean common mosaic, which causes light and dark green mosaic patterns of infected leaves.

COMMENTS ON THE DISEASE

Bean yellow mosaic has a wide host range in legumes and can readily overwinter in perennial legume crops (e.g., alfalfa, clovers) or weeds (vetch). It also commonly infects gladiolus. The virus is transmitted by over 20 species of aphids (e.g., the pea, green peach, and black bean aphids). Beans become infected when virus-carrying aphids move into bean fields. Transmission of the virus occurs within seconds once aphids begin feeding on the crop. Aphids can efficiently spread the virus within a field, resulting in high rates of infection. The virus is not known to be seed-transmitted in beans.

Bean yellow mosaic virus is in the same virus family as *Bean common mosaic virus* and commonly occurs in mixed infections with *Bean common mosaic virus* in field-infected plants. This can confuse diagnosis in the field, which can be particularly important in seed production fields. Antibody tests are often needed for the precise identification of these two viruses.

MANAGEMENT

Locate bean fields as far away from perennial legumes (alfalfa, clover, vetch) and gladiolus fields as possible. The best management approach is to plant resistant varieties. A number of *Bean yellow mosaic virus*-resistant dry bean varieties are available, whereas few snap bean varieties are resistant. Insecticide sprays to reduce the rate of spread of the virus by aphids are generally not effective, but may provide limited control if applied to nearby fields of forage legumes or to bean fields early in the season.

BLACK ROOT ROT (8/07)

Pathogen: *Thielaviopsis basicola*

SYMPTOMS

This disease occurs on blackeyes as well as on other dry bean types. Brown to black necrotic tissue develops on the below ground stems and roots. Fissures often develop in necrotic cortex tissue. Using a compound microscope the fungus can be identified in diseased tissue by the production of dark chlamydospores.

COMMENTS ON THE DISEASE

The fungus survives over a year in soil as chlamydospores. In blackeyes, *Thielaviopsis basicola* appears to be active on affected roots throughout the growing season.

MANAGEMENT

Long-term crop rotation to nonsusceptible crops such as grasses may help to reduce soil inoculum. Avoiding excess irrigation or long drought stress may help.

CHARCOAL ROT (ASHY STEM BLIGHT) (12/08)

Pathogen: *Macrophomina phaseolina*

SYMPTOMS

Charcoal rot is most serious on common beans and then blackeyes; it also occurs on limas. Symptoms may appear after the pathogen, which can be soilborne, germinates and infects seedling stems near the soil line at the base of developing cotyledons. The fungus produces black, sunken cankers that have a sharp margins and often contain concentric rings. The plant's growing tip may be killed or the stem broken where it is weakened by the canker. Infection may continue into the hypocotyl and root region or the primary leaf petioles. Root infection causes a brown to black necrosis. If plants are grown under dry land conditions, young plants can be killed.

Infection of older seedlings and plants may cause stunting, leaf chlorosis, premature defoliation, and plant death, especially during periods of high temperature and particularly following drought stress. On older plants "charcoal dust" often appears on the surface of the stems and is diagnostic evidence for this disease. This charcoal effect is caused by the production of small, black microsclerotia just below the epidermis and in the vascular tissue. This symptom is also called ashy stem blight.

COMMENTS ON THE DISEASE

The fungus is pathogenic on many crops including corn and sorghum, and the disease tends to be worse on certain soils. Although the fungus is capable of infecting plants at all stages of growth, severe disease primarily occurs under conditions of drought stress and high temperatures, especially when a late irrigation is applied.

MANAGEMENT

Avoid drought stress especially during periods of high temperature. A 3-year rotation with a cereal crop may help reduce soil inoculum.

COMMON BACTERIAL BLIGHT (8/07)

Pathogen: *Xanthomonas campestris* pv. *phaseoli*

SYMPTOMS

Symptoms of common bacterial blight first appear on leaves as small, watersoaked spots and/or light green areas. These spots enlarge and the tissue in the centers dies and turns brown. These irregularly shaped spots are bordered by a lemon yellow ring, which is a diagnostic symptom of common blight. These spots or lesions can develop on the edges or in interveinal areas of leaves. The spots may grow together, resulting in the death of the entire leaf and defoliation of the plant. Infected pods will first show small, watersoaked spots that develop into large, dark red irregular spots. Under favorable conditions, these spots may show a yellow slimy ooze (pod symptoms of common and halo blight diseases are virtually indistinguishable). Seed in infected pods can become infected; white-colored seed may show butter yellow spots when infected. Heavily infected seed may be shriveled and germinate poorly.

COMMENTS ON THE DISEASE

Like most bacterial diseases, common bacterial blight is favored by conditions of high moisture and humidity. Because of dry summers, this disease is uncommon in California. Although common blight bacteria can overwinter in infected debris, survival and dissemination in association with seed is more important. In fact, bean seed is produced in California because environmental conditions are unfavorable for development of bacterial diseases.

MANAGEMENT

Plant certified seed produced in arid regions unfavorable for development of bacterial diseases, such as California and Idaho. Avoid the use of sprinkler irrigation, which can provide the needed moisture and humidity for common bacterial blight development in California. In fields known to have had common blight problems, practice a 2 to 3 year rotation and deep plow infested debris. There are no commercially available resistant varieties, although some tolerant cultivars are available (e.g., Great Northern Harris). Bactericides or antibiotic sprays are generally not effective for controlling common blight.

CUCUMBER MOSAIC (8/07)

Pathogen: *Cucumber mosaic cucumovirus* (CMV)

SYMPTOMS

Symptoms of cucumber mosaic in common beans vary considerably and depend on the variety and strain of the virus. Severe symptoms may include dark green blisters and vein banding, interveinal yellowing and leaf distortion that may resemble damage due to the herbicide 2,4-D. Milder symptoms may include a light green to dark green mottle and some green vein banding, and can be confused with those caused by *Bean yellow mosaic potyvirus* and *Bean common mosaic viruses.*

COMMENTS ON THE DISEASE

Cucumber mosaic cucumovirus has a very wide host range and infects many crop, ornamental, and weed plants. However, only certain strains of *Cucumber mosaic cucumovirus* infect common beans, and these have been reported to also infect alfalfa, peas, pepper, lima bean, and blackeye. *Cucumber mosaic cucumovirus* can be seedborne in bean and is transmitted by aphids. It can also overwinter in perennial crops and weed hosts.

MANAGEMENT

Because this disease is not very common, it does not warrant the use of control measures. The use of certified seed will help minimize the incidence of seedborne cucumber mosaic. As for *Bean yellow mosaic virus,* growers may want to avoid growing beans adjacent to alfalfa fields or, in the case of *Cucumber mosaic cucumovirus,* established pepper fields. There are no *Cucumber mosaic cucumovirus* resistant varieties, although some varieties are more tolerant than others.

CURLY TOP (8/07)

Pathogen: *Beet curly top geminivirus* (BCTV)

SYMPTOMS

Plants infected with the *Beet curly top virus* show a striking down-cupping, puckering, and wrinkling of infected leaves. The leaves become thick and brittle and may turn dark green. The internodes of infected plants become shortened, resulting in a striking dwarfing and stunting of infected plants, particularly when plants are infected at an early stage of growth. These plants produce few if any pods. Plants infected at later stages of growth may senescence early, lose flowers, and produce stunted pods.

COMMENTS ON THE DISEASE

The *Beet curly top virus* has a wide host range that includes beans (especially blackeyes), tomatoes, peppers, sugarbeet, melons, and other crops. The virus overwinters in perennial and annual weeds (e.g., Russian thistle, mustard) in areas such as the foothills surrounding the Central Valley of California. The virus is acquired from these hosts by the beet leafhopper (*Circulifer tenellus*), and is transmitted to beans and other crops by this insect as it migrates from the foothills into agricultural areas. Yield losses caused by curly top vary considerably from year to year and can be associated with high leafhopper populations.

MANAGEMENT

Plant dry and snap bean varieties that are resistant or tolerant to the curly top virus in areas where curly top is known to occur. A statewide aerial spray program that targets areas harboring the leafhopper vector with insecticidal sprays before leafhopper migration may provide some control.

CUT OUT (BLACKEYES) (12/08)

SYMPTOMS

Cut-out or more correctly 'early-cutout' is when a large percentage of the plants simply senesces and then dies after the first flush of pods, usually beginning about 80 days after planting. The most common aboveground symptoms are that of early leaf senescence and defoliation. No new leaves or blooms occur at the buds, which may turn brown and abort.

COMMENTS ON THE DISEASE

Cut out should be considered a complex of symptoms rather than a specific disease. It may be caused by pathogens, or it may be a physiological response. It eliminates the possibility of additional podding, thereby shortening the season and potentially reducing yields by about 15 or more cwt/ac. A combination of a strong first set, variety, unknown soil pathogens and environmental factors seem to trigger the expression of cut out.

The soil pathogens *F. oxysporum* f. sp. *tracheiphilum* (Fusarium wilt), *F. solani* (Fusarium root rot), or *Thielaviopis basicola* may cause premature senescence of blackeyes. Infections by these organisms can be differentiated by symptoms. Fusarium wilt causes discoloration in the vascular system that extends from the roots into the aboveground stems and petioles (see FUSARIUM WILT). *Fusarium solani* causes rust-colored lesions on roots. Thielaviopsis root lesions are dark brown-black in color. Other pathogens that occur less frequently on roots of plants exhibiting early cut out are *Macrophomina phaseolina*, *Rhizoctonia solani*, and *Phytophthora drechsleri*.

MANAGEMENT

For physiological cut out avoid water stress to the plants after bloom. For Fusarium wilt, choose a resistant variety. For diseases caused by *F. solani* and *Thielaviopsis*, crop rotation will help prevent the build up of these pathogens in soil. Cut out appears to be more severe when plants are stressed by over or under irrigation or by soil compaction, so follow good water management practices, especially during reproductive growth, and avoid compacting the soil.

FUSARIUM ROOT ROT (12/08)

Pathogens: *Fusarium solani* f. sp. *phaseoli* (blackeyes, common bean) and *Fusarium solani* f. sp. *pisi* (garbanzo beans)

SYMPTOMS

Fusarium root rot is characterized by brick red lesions of variable size, with diffuse margins that develop on belowground stems and tap roots. The red color gradually turns brown with age. Longitudinal fissures develop in the cortical tissue of affected areas. In severe infections, the entire root system may be attacked and destroyed. If the surface of the lesion is scraped away, small red flecks can be seen in affected tissue; this is a good diagnostic characteristic. In some plants, roots are initiated above the lesion.

COMMENTS ON THE DISEASE

The causal fungi survive for several years as chlamydospores in the soil. The disease is most commonly encountered during mid- to late season in fields with a long history of bean culture. The disease causes little damage to unstressed plants but under conditions of reduced root growth caused by drought, poor nutrition, or oxygen stress caused by wet soil, *Fusarium solani* is one of the causes of early maturity (aka cut out) and marked reduction in yield.

MANAGEMENT

Long-term (3 years) crop rotation out of beans may reduce soil inoculum. Provide optimal growing conditions, avoiding stress caused by excess water, prolonged drought, soil compaction, etc. Although no bean line is immune, some cultivars are more tolerant to the disease than others.

FUSARIUM WILT (Blackeyes/Cowpeas) (12/08)

Pathogen: *Fusarium oxysporum* f. sp. *tracheiphilum*

SYMPTOMS

Symptoms of Fusarium wilt usually appear on medium-aged or older plants and begin as a yellowing and wilting of the lower leaves, sometimes more pronounced on one side of the plant. The wilting and yellowing then progress up the plant until the entire plant turns yellow. At this stage, the yellow plants are readily observed in the field. Plants also may be stunted, particularly if infected at a younger age.

The root and stems show few external symptoms (in contrast to Fusarium root rot caused by *F. solani*). Infected plants often have a swollen root compared to uninfected roots but otherwise may appear healthy on the surface. Discoloration of the vascular system is a diagnostic symptom of Fusarium wilt, and it can be readily seen by cutting into the lower stem and looking for a red-brown streaking in the vascular tissues. The discoloration is usually present in plants showing foliar symptoms and is particularly evident in the lower stem and at stem and petiole nodes.

COMMENTS ON THE DISEASE

Fusarium wilt has been a major problem in California blackeye production. It is the reason why the variety CB 5 was replaced in the 1980's by CB 46 which is resistant to the race 3, the predominant race of *Fusarium oxysporum* in the state. The pathogen is a specialized form of *F. oxysporum* that infects only cowpea but not lima beans, common beans, soybeans, or other crops. Like other Fusarium wilt pathogens, it can survive in soil for long periods of time, and continued cropping of blackeyes will result in the build-up of soil populations of *F. oxysporum* f. sp. *tracheiphilum* . It also has been reported to be an external contaminant of seed, which has likely facilitated the long distance dissemination of the pathogen.

MANAGEMENT

At this time in California, variety selection is the recommended management. CB 46 is resistant to Race 3, the most common race of *Fusarium oxysporum* in CA but is susceptible to Race 4, which has been identified in a few locations. Whenever practical, take efforts to minimize spread of the pathogen from infested to uninfested fields via farm machinery, irrigation equipment and water, and contaminated seed. If resistant plants are infected with root knot nematodes, then they may become susceptible. New varieties are being developed with resistance to both Race 3 and 4 and root knot nematode.

FUSARIUM WILT (Common Beans) (12/08)

Pathogen: *Fusarium oxysporum* f. sp. *phaseoli*

SYMPTOMS

Symptoms of Fusarium yellows or wilt usually appear on medium-aged or older plants and begin as a yellowing and wilting of the lower leaves. The wilting and yellowing then progress up the plant until the entire plant turns yellow. At this stage, the yellow plants are readily observed in the field. Plants also may be stunted, particularly if infected at a younger age.

The root and stems show few external symptoms (in contrast to Fusarium root rot caused by *F. solani*). Discoloration of the vascular system is a diagnostic symptom of Fusarium yellows, and it can be readily seen by cutting into the lower stem and looking for a red-brown streaking in the vascular tissues. The discoloration is usually present in plants showing foliar symptoms and is particularly evident in the lower stem and at stem and petiole nodes.

COMMENTS ON THE DISEASE

Fusarium yellows was first described in California in 1928 and it has subsequently spread throughout the United States and into Central and South America. Although the disease is not uncommon in California, it has not become a major problem. The pathogen is a specialized form of *F. oxysporum* that infects common bean but not lima beans, cowpeas, soybeans or other crops. Like other Fusarium wilt pathogens, it can survive in soil for long periods of time, and continued cropping of bean will result in the build-up of soil populations of *F. oxysporum* f. sp. *phaseoli*. It also has been reported to be an external contaminant of seed, which has likely facilitated the long distance dissemination of the pathogen.

MANAGEMENT

At this time in California, specific control measures for Fusarium wilt are usually not used. However, many of the controls recommended for Fusarium root rot may minimize Fusarium wilt, such as crop rotation. Whenever practical, take efforts to minimize spread of the pathogen from infested to uninfested fields via farm machinery, irrigation equipment and water, and contaminated seed. Resistance to Fusarium yellows has been identified in a number of bean accessions and could be incorporated into California varieties if the disease becomes a major problem.

FUSARIUM WILT (Garbanzo Beans) (8/07)

Pathogen: *Fusarium oxysporum* f. sp. *ciceri*

SYMPTOMS

In the field, lower leaf yellowing and often stunting of garbanzo bean plants are the earliest symptoms. Subsequently the plant wilts and dies. When root knot nematodes are present, symptoms are usually more severe. When the root or stem of the plant is cut tangentially with a sharp knife, the woody (xylem) tissue is dark brown. This pathogen does not ordinarily cause a root rot; however, root rots caused by other pathogens such as *Pythium* spp., *Fusarium solani*, *Thielaviopsis basicola*, and *Macrophomina phaseolina* may be associated with the disease.

COMMENTS ON THE DISEASE

Fusarium oxysporum survives in soil for several years as chlamydospores and is specific to garbanzos. The fungus is systemic and once the plant is infected, it cannot be cured.

Care should be taken to differentiate Fusarium wilt from a yellows disease caused by one or more viruses that are transmitted by aphids. The viruses will cause yellowing of the plant but the color is brighter than with Fusarium wilt. If a virus disease is suspected, the main symptom to look for is a dark brown color of the bark tissue (phloem or sugar conducting tissue) when cut open with a sharp knife.

MANAGEMENT

Long-term crop rotation (over 5 years) may help to reduce inoculum in soil. In fields with a history of Fusarium wilt, resistant cultivars should be planted. UC-15, adapted to coastal areas, and UC-27, adapted to the Central Valley, are resistant.

HALO BLIGHT (8/07)

Pathogen: *Pseudomonas syringae* pv. *phaseolicola*

SYMPTOMS

Halo blight symptoms first appear as small, angular, watersoaked spots (almost resembling little pin pricks) on the undersurfaces of leaves. As these spots grow and turn brown, a characteristic light green to yellow halo appears around the spots. This halo is due to the action of a toxin produced by the bacteria and is a diagnostic symptom of the disease. In severe infections the leaves and upper parts of plants turn yellow (chlorotic). On pods, small watersoaked spots, about the size of pin pricks, develop that grow into sunken spots and turn reddish brown. Under favorable conditions, a creamy white ooze may be seen inside these spots (pod symptoms of common and halo blight diseases are virtually indistinguishable). Seed in infected pods may become infected, and appear shriveled, discolored, and/or smaller than normal size.

COMMENTS ON THE DISEASE

Halo blight disease occurs worldwide and can cause extensive losses under favorable conditions, which are moderate temperatures (60° to 73°F, 16° to 23°C) and humid moist conditions. Fortunately, such conditions are unusual in California and thus halo blight is uncommon on beans grown in California. Halo blight bacteria can overwinter in infested debris or in association with seed; infested seed is the most important inoculum source.

MANAGEMENT

Control of halo blight is very similar to the control for common bacterial blight. Plant certified seed produced in arid regions unfavorable for development of bacterial diseases, such as California and Idaho. Avoid the use of sprinkler irrigation, which can provide the needed moisture and humidity for common blight development in California. In fields known to have had common blight problems, practice a 2 to 3 year rotation and deep plow infested debris. Resistant varieties are available and should be used when appropriate.

SEEDLING DISEASES (12/08)

Pathogens: *Pythium* spp., *Rhizoctonia solani*, and *Thielaviopsis basicola*

SYMPTOMS

Pythium spp. usually cause preemergence rot and in some cases damping-off of young seedlings. Symptoms include water-soaked lesions with eventual collapse of the hypocotyl at or below ground. Occasionally, older plants are infected and develop water-soaked lesions that extend some distance up the stem, causing a linear band of dead cortical tissue.

Rhizoctonia solani causes postemergence damping-off of the seedlings that is characterized by sharp-edged oval to elliptical reddish brown lesions on the hypocotyl. Heavy infection may girdle the stem and the seedlings may die. Often the lesions heal over as the plant ages. Rhizoctonia root canker also occasionally occurs on the upper tap roots of older plants as discrete, reddish brown lesions.

Thielaviopsis basicola causes a black root rot on young seedlings and older plants. The dark discoloration of roots and the presence of typical chlamydospores (visible with a microscope) are diagnostic of this pathogen.

COMMENTS ON THE DISEASES

The fungi involved occur commonly in soils. Most *Pythium* spp. are active during cool, wet weather, but *P. aphanidermatum* is favored by high temperatures. Seedling diseases caused by *Pythium* spp. are usually not severe unless beans are planted in cold soils or over watered. *Rhizoctonia solani* is favored by warm soil temperatures, but varies widely in temperature requirements. Often the population of *R. solani* is higher when the crop follows alfalfa or sugarbeets.

MANAGEMENT

Cultural Control

For blackeyes, planting when the average soil temperature is greater than 68°F (20°C) and in soil that is moist but not overly wet is the first line of defense. Irrigation following planting favors both *Pythium* and *Rhizoctonia*. Plant shallowly to minimize exposure of susceptible areas of the hypocotyl. Crop rotation may help reduce inoculum in the soil.

Organically Acceptable Methods

Cultural control is organically acceptable.

Monitoring and Treatment Decisions

Seed treatments may be helpful in fields with a history of seedling disease. Include a fungicide that is toxic to *Pythium*, and another that is toxic to *Rhizoctonia solani*. There are no treatments effective against *Thielaviopsis basicola*. If seedling disease appears during crop emergence, consider using treated seed in the future.

Common name (trade name)	Amount to Use**

When choosing a pesticide, consider information relating to environmental quality.

Note: When using treated seed, be sure to place it in the furrow below the granular rhizobia.

***SEED TREATMENTS* (*Pythium* spp.)**

A. MEFENOXAM
(Apron) TL — 2–4 fl oz/100 lb seed
MODE OF ACTION GROUP NAME (NUMBER[1]): Phenylamide (4)

***SEED TREATMENTS* (*Rhizoctonia solani*)**

A. PCNB (24%) — 3 fl oz/100 lb seed
MODE OF ACTION GROUP NAME (NUMBER[1]): Aromatic hydrocarbon (14)

Common name (trade name)	Amount to Use**

B. CHLORONEB
(NU-Flow D 30%) 7 fl oz/100 lb seed
MODE OF ACTION GROUP NAME (NUMBER[1]): Aromatic hydrocarbon (14)

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. For fungicides with mode of action Group numbers 1, 4, 9, 11, or 17, make no more than one application before rotating to a fungicide with a different mode of action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode of action Group number.

SOUTHERN BLIGHT (8/07)

Pathogen: *Sclerotium rolfsii*

SYMPTOMS

Initial symptoms of southern blight include a yellowing of the foliage with slight darkening of the stem just above the soil line. Lesions on the stem at or near the soil line develop rapidly, girdling the stem and result in a sudden and permanent wilt of the plant. The fungus grows downward in the stem and root, rotting the cortical tissue. White mats of mycelium develop on the stem and in adjacent soil. In a few days, tan to brown spherical sclerotia (small dormant structures) about 0.06 inch (1.5 mm) in diameter appear on the mycelial mat. The abundant sclerotia are a good diagnostic feature of this disease.

COMMENTS ON THE DISEASE

High temperatures (above 85°F or 29°C) favor the disease. The fungus attacks a wide range of plants and survives for long periods in the soil as sclerotia. Southern blight is usually a minor disease of beans in California.

MANAGEMENT

Rotation to nonhosts such as corn or small grains for at least 2 years reduces inoculum. Burying plant refuse helps destroy sclerotia.

WHITE MOLD (12/08)

Pathogens: *Sclerotinia sclerotiorum* and *S. trifoliorum*

SYMPTOMS

White mold first appears as a watery rot on stems, leaves, and pods. White mycelium is often visible on the surface of rotted tissue under moist conditions. The development of black, irregularly shaped sclerotia is the best diagnostic feature. The disease may occur on the stem near the soil line (especially common in garbanzo beans) or more commonly, on pods, leaves, and stems. Affected tissue dries quickly and bleaches to a pale tan or almost white color. Entire branches or stems may be killed, which results in yellow flagging in the field. When the main stem is affected near the soil line, the entire plant may be killed.

COMMENTS ON THE DISEASE

Sclerotia survive in the soil for several years. After several weeks of moist and cool (39°F or 4°C) conditions, sclerotia within 2 inches of the soil surface are preconditioned to produce mushroomlike fruiting structures called apothecia, which form after one to several weeks of temperatures at 52° to 68°F (11° to 20°C) in moist soil. Airborne spores (ascospores) are then released from the apothecia by changes in relative humidity and germinate on plants parts, especially senescing flower parts. Ascospores commonly colonize senescent petals that are attached or detached. The fungus may remain viable in blossoms for a month. Plant surfaces in contact with blossoms must remain continuously wet for 48 to 72 hours for infection to occur. White mold develops most rapidly at 68° to 77°F (20° to 25°C). White mold is generally more severe in fields with heavy canopies.

Other plant surfaces, especially the lower stem near the soil surface, appear to be susceptible, even before flowering. It is possible that some sclerotia germinate directly and infect the crown of a plant through mycelial invasion.

Sclerotinia sclerotiorum infects many cultivated plants and weeds. Ascospores may blow in from other fields and start epidemics in beans.

MANAGEMENT

Cultural Control

Rotation with nonhosts, such as small grains and corn, may reduce soil inoculum. However, many weeds are hosts and may maintain the fungus. Airborne ascospores may also blow in from surrounding fields. Avoid heavy applications of nitrogen to reduce excessive canopies. Wide row spacings may help keep the foliage dry.

Monitoring and Treatment Decisions

Start inspecting plants for symptoms of white mold along with other pests and their damage during the pod fill stage. Chemical control is difficult because infection is often limited to plant parts covered by the leaf canopy. Apply fungicides during the flowering period to provide coverage on senescing petals.

Common name (trade name)	Amount to Use**	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to environmental quality.			
A. THIOPHANATE METHYL (Topsin M) 70WP	1–1.5 lb	12	28
MODE OF ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
B. BOSCALID (Endura)	8–11 oz	12	21
MODE OF ACTION GROUP NAME (NUMBER[1]): Carboxamide (7)			
COMMENTS: Do not exceed 2 applications/year.			

** Mix with sufficient water to obtain full coverage.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. For fungicides with mode of action Group numbers 1, 4, 9, 11, or 17, make no more than one application before rotating to a fungicide with a different mode of action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode of action Group number.

Abiotic Disorders

Abiotic disorders, those caused by noninfectious (abiotic) conditions, are as common as diseases caused by infectious agents such as fungi, bacteria, and viruses.

BALDHEAD (12/08)

SYMPTOMS
Baldhead is a condition that occurs when seedlings are severely stunted and have little or no growth above the primary (first) leaves as a result of death or damage of the growing point.

COMMENTS ON THE DISEASE
Baldhead is due to physical damage to the seed, which may occur during harvesting, threshing, cleaning, handling, or planting operations. Seed with low moisture content is most susceptible to such damage.

MANAGEMENT
Exercise care during harvest, storage, and planting of bean seed. Moisture content of seed should be maintained around 14 to 15%.

NUTRIENT DEFICIENCY AND TOXICITY (8/07)

Beans require proper nutrition for normal growth and yields, and deficiencies and/or excesses of nutrients can cause disease-like conditions.

SYMPTOMS
Symptoms vary depending on the nutrient involved, the cultivar, and the environmental conditions. In general symptoms include the overall yellowing, bronzing, or purpling of plants and/or light green or yellow areas in between dark green veins. Plants tend to be stunted and show poor growth.

COMMENTS ON THE DISEASE
The most common nutrient deficiencies occur with magnesium and phosphorous; others include: boron, calcium, copper, iron, manganese, nitrogen, phosphorous, sulfur, and zinc. Toxicities include aluminum, boron, and manganese. Soil pH plays an important role in availability of nutrients. Low soil pH is associated with: aluminum toxicity, calcium deficiency, magnesium toxicity or deficiency, manganese deficiency, and/or nitrogen and phosphorous deficiency. High soil pH is associated with: boron, iron, manganese, and zinc deficiencies. Soil or plant tests may be needed to precisely determine nutrient problems.

MANAGEMENT
Know the pH and nutritional properties of the fields in which beans are to be planted and follow recommended practices for cultivation of beans. Adjust pH and/or nutrient levels when necessary.

OZONE INJURY (8/07)

SYMPTOMS
Ozone symptoms vary depending on the type of pollutant and concentration, the cultivar, and environmental conditions. The most common symptoms of ozone damage on field-grown beans is bronzing, in which a purple-brown discoloration develops on the upper surface of the leaves.

COMMENTS ON THE DISEASE
Ozone injury is caused by high levels of ozone (O_3) in the air. Ozone is generated by the interaction of atmospheric components and the products of combustion engines. The problem is favored under conditions of high temperature and light intensity.

MANAGEMENT
Some tolerant cultivars are available.

SUNSCALD (8/07)

SYMPTOMS
Sunscald symptoms first appear as small water-soaked spots on upper surfaces of leaves, stems, or pods that are exposed to the sun. These spots are generally close together, turn reddish brown, and form large spots on affected plant parts.

COMMENTS ON THE DISEASE
This condition is caused by exposure to intense sunlight and/or high temperatures. The problem tends to be most severe following periods of high humidity and overcast skies.

MANAGEMENT
None available.

WIND AND SAND DAMAGE (8/07)

SYMPTOMS
Bean leaves and pods can be damaged by the physical action of wind and wind-blown sand. Two types of wind-induced damaged can occur. The first is long tears in leaves, which is most common during hail storms. More commonly, damage is a result of rubbing injury, which appears on leaves as shiny greenish tan areas and on pods as elongate, discolored streaks or lesions that develop into raised or bumpy spots.

COMMENTS ON THE DISEASE
High speed winds combined with blowing sand or hail can cause significant damage to bean plants, particularly those that have a tall growth habit and large leaves.

MANAGEMENT
When warranted and possible, grow short compact cultivars with small leaves, and plant rows in the direction of prevailing winds to minimize swaying.

Nematodes (12/08)

Scientific Names: Root knot nematodes: *Meloidogyne incognita*, *Meloidogyne arenaria*, *Meloidogyne hapla*, and *Meloidogyne javanica*
Lesion nematodes: *Pratylenchus scribneri* and *Pratylenchus* spp.

DESCRIPTION OF THE PESTS
Plant parasitic nematodes are microscopic roundworms that feed on plant roots. They survive in soil and plant tissues, and several species may occur in a field. They have a wide host range and vary in their environmental requirements and in the symptoms they cause.

DAMAGE
Only root knot nematodes are known to cause significant damage. Yield reductions due to high populations of root knot nematodes may range from 45 to 90%. Yield losses due to root knot infestation are typically most severe in sandy soils. These nematodes are also known to predispose plants to other soilborne pathogens that cause root rot and wilt diseases. Lesion nematodes can be damaging but are infrequently encountered compared to root knot nematode. Other nematodes (e.g., stunt and stubby root) have been associated with dry beans in California but have not been studied.

SYMPTOMS
Symptoms described below are indicative of a nematode problem, but are not diagnostic as they could result from other causes as well.

Aboveground symptoms of severe root knot infestation include patches of chlorotic, stunted, necrotic, or wilted plants. Infested plants that are also under moisture or temperature stress may wilt earlier than other plants. Feeding by root knot nematode incites cell enlargement and proliferation resulting in swellings, called galls, on roots. These galls are diagnostic for root knot nematode, however, some bean types do not gall much. An example is the blackeye CB3, which is susceptible to root knot nematode and can support high populations of this nematode but shows little galling. Severely galled roots may be shortened and thickened. Galls caused by root knot nematodes may be confused with nodules of nitrogen-fixing *Rhizobium* bacteria. *Rhizobium* nodules, however, are pink inside and come off the root easily when rubbed. Root knot galls cannot be separated from the root.

Roots of bean plants infested with lesion nematodes are likely to be poorly developed and may exhibit brown-black lesions. Damage to roots by lesion nematodes may be more severe in the presence of other soilborne pathogens.

FIELD EVALUATION
To make effective management decisions, it is important to know the nematode species present and to estimate their population density in soil. If a previous crop had problems caused by nematodes that are also listed as pests of dry beans, population levels may be high enough to cause damage. Develop and track field histories to monitor the presence of root knot nematode on previous crops.

If nematode species have not previously been identified, take soil samples and send them to a diagnostic laboratory for identification. The best time to collect samples is soon after harvest or preferably just before harvest of the previous crop. Divide the field into sampling blocks that are representative of cropping history, crop injury, or soil texture. An ideal sampling size is 5 acres, but a larger sampling size (no greater than 20 acres) may be more economical. In each block randomly take several subsamples from the root zone of the previous crop, mix them thoroughly and make a composite sample of about one quart (1 liter). Place samples in separate plastic bags, seal them, and place a label on the outside with your name, address, location, and the current/previous crop and the crop you intend to grow. If plants with symptoms are available, place them in the same bag as the soil. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Contact your farm advisor to help you find a laboratory for extracting and identifying nematodes, and for help in interpreting sample results.

MANAGEMENT
Management of nematodes in dry beans requires a careful integration of several cultural practices, including choice of cultivar, crop rotation, sanitation, and fallow.

Resistant varieties. Large lima bean cultivars that are resistant to *Meloidogyne incognita* are White Ventura N. Maria, UC-90, and UC-92. The baby lima bean cultivar, Cariblanco N, has resistance to root galling and reproduction by *M. incognita* and root galling by *M. javanica.* UC 302 has resistance to some races and is due to be released in the next year or two. Blackeye #5 and CB-46 are highly resistant to most, but not all populations of *M. incognita* but susceptible to *M. javanica*. CB-50 is a new cultivar with strong resistance to *M. incognita* and moderate resistance to *M. javanica.*

Crop rotation and cover crops. Growing small grains during the winter followed by a fallow period during the summer helps to reduce root knot nematode populations. Clean fallow and green manure will help to reduce populations of root knot nematodes. Growing cover crops of oats (cv. *Saia*), marigolds, rattlebox (*Crotalaria spectabilis*), hairy indigo (*Indigo hirsuta*), etc., is known to reduce populations of plant parasitic nematodes. Also, research in Stanislaus County demonstrated that a rotation of root knot nematode resistant processing tomatoes with common and Lima beans was successful in preventing root knot damage to beans. This is because root knot nematode were unable to reproduce on the resistant tomatoes, thereby reducing soil populations to below damaging levels. A similar benefit from reduced soil populations can be achieved by a preceding crop of root knot nematode-resistant cotton, NemX.

Sanitation. Clean soil from equipment with water before moving from infested to noninfested fields.

Fallow. Weed free fallow reduces most nematode populations. Fallowing is more effective if the soil is plowed and exposed to the sun. Irrigation during the dry period stimulates nematode egg hatch, and so further reduces nematode populations if proper weed control is maintained.

Monitoring and treatment decisions. During the flower bud to bloom period inspect plants for nematode damage along with other pests and their damage. If a plant looks stunted, check its roots for galling. Damage thresholds have not been established for nematodes on beans. In California, the use of chemical treatments has not been found to be cost effective. Contact your farm advisor or agricultural commissioner for further advice on the use of chemical treatments.

	Common name (trade name)	Amount / Acre	R.E.I.+ (hours)	P.H.I.+ (days)
When choosing a pesticide, consider information relating to environmental quality.				
PREPLANT				
A.	ALDICARB* COMMENTS: Follow label directions.	Label rates	48	90
B.	METAM SODIUM* (Vapam) COMMENTS: Metam sodium can effectively control nematodes if applied properly, but it is not usually applied properly, resulting in poor penetration of plant roots and difficulty in getting it to penetrate 4–5 feet down from the surface. Before applying this material, thoroughly cultivate the area to be treated to break up clods and deeply loosen the soil. After cultivation and about 1 week before treatment, preirrigate the field with 6–8 acre-inches of water in flood irrigation in basins. After treatment, do not plant for 30 days, or 60 days if soil is high in organic matter or cold (below 50°F). Fumigants such as metam sodium are a source of volatile organic compounds (VOCs), which are a major air quality issue. Fumigate only as a last resort when other management strategies have not been successful or are not available.	Label rates	48	0
C.	1,3 DICHLOROPROPENE* COMMENTS: Follow label directions.	Label rates	7 days	0
D.	ETHOPROP* COMMENTS: For use on dry lima beans only.	Label rates	72	0

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

Weeds

INTEGRATED WEED MANAGEMENT (12/08)

Effective weed control for dry bean production requires integration of sound cultural practices and herbicide use. It is necessary to carefully plan a program of crop rotation, cultural practices, and herbicide use. The type of program developed depends on bean variety, species of weeds, crop rotation, soil type, and irrigation system used in growing the crop.

MONITORING and FIELD PLANNING

Monitor the field before harvesting the preceding crop, about 4 weeks after the beans are planted, and just before harvest. Identify summer annuals, winter annuals, and perennial weeds.

Record observations on a monitoring form (*example formavailable online*). Determine the dominant weed species present and maintain records of weed species and severity of weed infestations for each field planted to beans. Anticipating certain weeds can aid greatly in designing the optimum weed control program. Avoid fields severely infested with such perennial weeds as bermudagrass, johnsongrass, nutsedge (nutgrass), and field bindweed. Weed control can also be difficult in fields heavily infested with certain annual weeds such as nightshade, groundcherry, and annual morningglory. To obtain a satisfactory crop from a weedy field, a grower must select locally adapted bean varieties and appropriate herbicides, and manage the field with care.

WEED MANAGEMENT BEFORE PLANTING

Cultural techniques aimed at suppressing weed growth, and good farming practices in general, are necessary parts of any weed control program.

A preirrigation to germinate weeds followed by a shallow bed tillage before planting will temporarily control many annual weeds and leave 1 to 2 inches of dry soil on the surface to further slow weed seed germination. Vine-type bean varieties are very competitive to weeds and prevent weed germination if allowed to cover and shade the ground before an irrigation is applied. Plant bush-type varieties in narrow rows, 30-inch centers or closer, or in three rows on a 60-inch bed. Vine-type varieties like limas are suited to 30- to 42-inch centers or two rows on 60-inch beds.

If one week or more passes between bed preparation and planting, weed seedlings may begin to emerge. Weeds will need to be treated with a contact herbicide or, before planting, run a blade or rolling cultivator at 1 to 1.5 inches below the soil surface to remove seedlings, giving the bean plants a head start on emerging weeds. This practice conserves more soil moisture than other cultural methods.

Furrow irrigating of beans for germination instead of planting into moisture must be done carefully, otherwise it can cause soil crusting and lead to seed rot. It also causes weeds to germinate simultaneously with the beans. Furrow irrigating for germination is especially risky on heavy clay soils prone to excessive saturation. Sprinkler irrigation is a safer method to use for germination and to avoid problems from excess water.

Herbicides. Combine preplant herbicides with cultural methods to achieve optimum weed control. Weeds that escape control by preplant herbicides may sometimes be effectively controlled by a postplant treatment.

Herbicides registered for use in beans differ in the weeds they control and the conditions under which they are optimally used. Rates may vary, depending on the texture, moisture, and organic matter content of the soil. In addition, different classes of beans vary in their tolerance to different herbicides, so herbicides must be chosen based on the class of beans to be grown. Herbicides can be applied either pre- or postemergence, according to the growth stage of the weeds. **Preemergent herbicides** are applied and incorporated before weeds have emerged, whereas **postemergent herbicides** control weeds that have already emerged. Some herbicides are effective as both pre- and postemergents. **Herbicide combinations** frequently are the most effective way to control multiple weed species.

Most preplant herbicides are applied to the soil surface and mechanically mixed into the soil before the crop is planted; these are called preplant incorporated herbicides and require soil moisture for best performance.

Herbicides may be applied to existing beds and incorporated with a power tiller, or applied broadcast, followed by discing and forming raised beds.

It is important to thoroughly incorporate preplant herbicides 2 to 4 inches deep. When incorporating with a disc or harrow, work the soil to double the depth of incorporation desired (i.e., 4–8 inches). Pull disc and harrows across the field twice at right angles. A power incorporator will incorporate to the depth for which it is set. A ground-driven tiller (rolling cultivator) must be set properly to the correct depth for thorough soil mixing and pulled at the proper speed. Two passes are required with a rolling cultivator for proper soil incorporation.

WEED MANAGEMENT AFTER PLANTING

After bean plants have germinated and reached the third to fourth trifoliate leaf stage, cultivation with sweeps, knives, or rolling cultivators can significantly reduce weed growth that may have survived earlier cultural or chemical control methods. Cultivate with care to avoid damaging bean seedling stems or cutting roots; such injuries predispose seedling to soil diseases and retard crop growth.

Late season weed infestations often hinder harvest operations and increase harvesting and cleaning costs. Weed trash can also lower bean quality, and the presence of certain toxic weeds (nightshade berries) can render the beans unsuitable for canning. In addition, weeds produce a lot of seed that remains in the soil and can infest succeeding crops.

Groundcherry, black nightshade, and hairy nightshade berries severely reduce bean quality during harvesting because they do not dry in windrows. During threshing, berry juices stain the beans; the sticky juices on the beans collect dirt and debris during harvest and warehouse handling that cannot be cleaned off. The sticky seeds of these weeds may also slow down or clog the thresher. In storage, moisture from berries can lower quality. Berries left in the field will infest the soil for the following year. If present, pull and carry these weeds out of the field before harvesting.

WEED MANAGEMENT PREHARVEST

Carfentrazone (Shark) may be applied to beans at maturity as a preharvest treatment to burn down broadleaf weeds such as annual morningglory, nightshades, pigweed, and lambsquarters. Make applications when the crop is mature and bean have begun to dry down. Complete coverage is essential for best results.

SPECIAL WEED PROBLEMS (12/08)

Fields with heavy infestations of these weeds are generally not suitable for dry bean production until the infestation is brought under control by rotating to other crops and using herbicides that are registered in these crops.

ANNUAL MORNINGGLORY. The dense foliage of annual morningglory can engulf a stand of dry beans. Seeds germinate down to a depth of 4 inches (10 cm) or more, much deeper than most annuals. Most seedlings emerge following irrigations, but they may also appear when surface soil is too dry to allow germination of other annuals. Seeds remain viable in soil for long periods.

Control of annual morningglory is critical from crop emergence to harvest. Destroy seedlings while they are small, because once they have twined up stems they are difficult to control without injuring the crop. Vine types of bean varieties that cover the entire soil surface will outcompete this weed and reduce its growth. In rotation crops such as corn, herbicides that effectively control this weed are registered.

FIELD BINDWEED. If possible, avoid growing beans in fields infested with field bindweed as there are no herbicides registered for postemergent application in beans in California that controls this weed.

Bindweed is a persistent perennial weed and control should be an ongoing program. For annual crops like beans, take control measures before planting to reduce the population. Fall treatments in September or October of glyphosate (Roundup) or 2,4-D will reduce spring populations and help beans to get a head start. If bindweed has emerged before planting, tillage or glyphosate treatments are suggested.

NIGHTSHADES (BLACK, HAIRY). Avoid planting seed contaminated with nightshade seed or especially planting to a nightshade-infested field. Both nightshade species are tall and therefore major competitors with beans for sunlight. They also cause serious harvesting problems. During threshing berries rupture releasing pigmented and sticky juice that stains crop seed and causes dirt and nightshade seed to stick to it. Nightshades are prolific seed producers, have seed that are viable for many years in the soil, and are tolerant to many herbicides. Therefore, successful nightshade control requires preventing them from producing seed.

Plan a crop rotation with a crop that has registered herbicides that are effective for nightshade control, such as corn. Winter cereals may be good choices because of the herbicides that are registered in these crops. In blackeyes/cowpeas, early suppression or control can be achieved with metolachlor (Dual) or high rates of ethalfluralin (Sonalan). High rates of ethalfluralin, however, may damage crop seedlings if the temperatures turn cool after planting. There are no herbicides that will give long enough control that when the beans start to senesce towards the end of the season and light reaches the soil prevents the nightshades from growing and setting seed before the field can be harvested.

NUTSEDGES. Both yellow and purple nutsedge are serious problems in dry bean fields and should be controlled in rotation crops. To suppress these weeds, use EPTC (Eptam) or metolachlor (Dual Magnum) in a preplant incorporated application. Several cultivations can also be made until the bean plants cover the rows to suppress populations.

Plant winter cereals as a rotation for summer fallow and chemical control with glyphosate.

COMMON AND SCIENTIFIC NAMES OF WEEDS (12/08)

Common Name	Scientific Name
barnyardgrass	*Echinochloa crus-galli*
bermudagrass	*Cynodon dactylon*
bindweed, field	*Convolvulus arvensis*
canarygrass, littleseed	*Phalaris* spp.
cocklebur, common	*Xanthium strumarium*
foxtail, yellow	*Setaria pumila*
goosefoot, nettleleaf	*Chenopodium murale*
groundcherries	*Physalis* spp.
johnsongrass	*Sorghum halepense*
knotweed, prostrate	*Polygonum aviculare*
lambsquarters, common	*Chenopodium album*
lettuce, prickly	*Lactuca serriola*
mallow, little (cheeseweed)	*Malva parviflora*
morningglory, annual	*Ipomoea* spp.
mustards	*Brassica* spp.
nettles	*Urtica* spp.
nightshade, black	*Solanum nigrum*
nightshade, hairy	*Solanum sarrachoides*
nutsedge, purple	*Cyperus rotundis*
nutsedge, yellow	*Cyperus esculentus*
oat, wild	*Avena fatua*
pigweeds	*Amaranthus* spp.
puncturevine	*Tribulus terrestris*
purslane, common	*Portulaca oleracea*
shepherd's-purse	*Capsella bursa-pastoris*
smartweed, pale	*Polygonum lapathifolium*
sowthistle, annual	*Sonchus* spp.
thistle, Russian	*Salsola tragus*
tomatillo	*Physalis philadephica*
velvetleaf	*Abutilon theophrasti*
wheat, volunteer	*Triticum* spp.

SUSCEPTIBILITY OF WEEDS TO HERBICIDE CONTROL

(12/08)

	PREPLANT							POSTPLANT			
	24D*	EPT	ETH	GLY	MET	PEN	TRI	CAR	BEN	CLE	SET
ANNUAL WEEDS											
barnyardgrass	N	C	C	C	C	C	C	N	N	C	C
canarygrass	N	C	C	C	C	C	C	N	N	C	C
cocklebur, common	C	N	—	C	—	N	N	P	C	N	N
foxtail, yellow	N	C	C	C	C	C	C	N	N	C	C
goosefoot, nettleleaf	C	C	C	C	N	C	C	—	N	N	N
groundcherry	C	C	P	C	C	N	N	C	C	N	N
knotweeds	P	P	C	P	—	C	C	—	—	N	N
lambsquarters, common	C	P	C	C	C	C	P	C	C	N	N
lettuce, prickly	C	C	N	C	P	N	N	—	—	N	N
mallow, little (cheeseweed)	P	N	N	P	P	N	N	C	—	N	N
morningglory, annual	C	—	—	P	N	N	N	C	P	N	N
mustards	C	N	N	C	N	N	N	P	C	N	N
nettle	P	C	C	N	C	C	P	C	—	N	N
nightshade, black	C	P	C	C	P	N	N	C	C	N	N
nightshade, hairy	C	P	C	C	C	N	N	C	C	N	N
oat, wild	N	C	N	C	P	N	N	N	N	C	C
pigweeds	P	P	C	C	C	C	C	C	C	N	N
puncturevine	C	P	C	C	N	C	C	—	N	N	N
purslane, common	C	C	C	P	P	C	C	N	C	N	N
shepherd's-purse	C	P	N	C	C	N	N	P	C	N	N
smartweed, pale	P	C	—	C	P	—	—	—	N	N	N
sowthistle	C	C	N	C	P	N	P	N	—	N	N
thistle, Russian	C	N	C	C	N	P	P	—	—	N	N
velvetleaf	C	N	N	P	N	P	N	C	C	N	N
wheat, volunteer	N	C	N	C	N	N	N	N	N	C	C
PERENNIAL WEEDS											
bermudagrass (seedling)	N	C	—	C	N	C	C	N	N	C	C
bermudagrass (established)	N	N	—	C	N	N	N	N	N	P	P
bindweed, field (seedling)	C	N	—	C	P	P	P	C	P	N	N
bindweed, field (established)	P	N	—	P	P	N	P	P	N	N	N
johnsongrass (seedling)	N	C	—	C	C	C	C	N	N	C	C
johnsongrass (established)	N	N	—	C	N	N	N	N	N	C	C
nutsedge, purple	N	P	—	P	N	N	N	N	N	N	N
nutsedge, yellow	N	P	—	P	P	N	N	N	P	N	N

C = control P = partial control/suppression N = no control — = no information

24D* = 2, 4-D (various products)
BEN = bentazon (Basagram)
CAR = carfentrazone (Shark)
CLE = clethodim (Select Max)
EPT = EPTC (Eptam)
ETH = ethalfluralin (Sonalan)
GLY = glyphosate (Roundup)
MET = metolachlor (Dual Magnum)
PEN = pendimethalin (Prowl)
SET = sethoxydim (Poast)
TRI = trifluralin (Treflan)

* Permit required from county agricultural commissioner for purchase or use.

HERBICIDE TREATMENT TABLE (12/08)

Herbicide common name (trade name)	Amount/Acre	R.E.I.+ (hours)	P.H.I.+ (days)

When choosing an herbicide, consider information relating to environmental quality.

PREPLANT

Before weeds emerge

A. METOLACHLOR — 0.9525–1.905 lb a.i. — 24 — 0
(Dual Magnum) — 1–2 pt
WSSA MODE OF ACTION GROUP NUMBER[1]: 15
COMMENTS: Preplant incorporate uniformly and thoroughly 2–4 inches deep. Avoid deep planting in cold, wet soil. Do not cut for hay within 120 days.

B. PENDIMETHALIN — 0.7125–1.425 lb a.i. — 24 — 0
(Prowl) H2O — 1.5–3 pt
WSSA MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Preplant incorporate within 7 days after application. Don't use on peat or muck soils.

C. EPTC — 3.0625 lb a.i. — 12 — 0
(Eptam) 7E — 3.5 pt
WSSA MODE OF ACTION GROUP NUMBER[1]: 8
COMMENTS: Preplant incorporate. Use lower rate in coarse, sandy soil. Do not use on Adzuki beans, cowpeas, soybeans, limas, Mung beans, garbanzos, or other flat-podded beans, except Romanos.

D. ETHALFLURALIN — 0.56–1.125 lb a.i. — 24 — 0
(Sonalan) — 1.5–3 pt
WSSA MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Preplant incorporate to 2–3 inches. Injury may occur at high rates in deep plantings and in cold, wet, or sandy soil.

E. TRIFLURALIN — 0.5–1 lb a.i. — 12 — 0
(Treflan, Trilin) — 1–2 pt
WSSA MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Preplant incorporate within 24 hours after application.

After weeds emerge

A. GLYPHOSATE
(Roundup) — Label rates — see label — see label
WSSA MODE OF ACTION GROUP NUMBER[1]: 9

B. 2,4-D* — Label rates — see label — see label
(various products)
WSSA MODE OF ACTION GROUP NUMBER[1]: 4

Herbicide combinations

A. METOLACHLOR — 0.925–1.905 lb a.i. — 24 — 0
(Dual Magnum) — 1–2 pt
WSSA MODE OF ACTION GROUP NUMBER[1]: 15
. . . PLUS . . .
TRIFLURALIN — 0.5–1 lb a.i. — 12 — 0
(Treflan, Trilin) — 1–2 pt
WSSA MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: Preplant incorporated. Common and lima beans.
. . . or . . .
PENDIMETHALIN — 0.7125–1.425 lb a.i. — 24 — 0
(Prowl) H2O — 1.53–3 pt
WSSA MODE OF ACTION GROUP NUMBER[1]: 3
COMMENTS: For tank mixes, observe directions for use on all labels, and employ the most restrictive limits and precautions.

Herbicide common name (trade name)	Amount/Acre	R.E.I.+ (hours)	P.H.I.+ (days)
B. ETHALFLURALIN	0.465–1.6875 lb a.i.	24	0
(Sonalan)	1.24–4.5 pt		
WSSA MODE OF ACTION GROUP NUMBER[1]: 3			
. . . PLUS . . .			
METOLACHLOR	1.905 lb a.i.	24	0
(Dual Magnum)	2 pt		
WSSA MODE OF ACTION GROUP NUMBER[1]: 15			
COMMENTS: Preplant incorporated. Common beans. Higher rates of ethalfluralin for groundcherry and nightshade control only. For tank mixes, observe directions for use on all labels, and employ the most restrictive limits and precautions.			
C. EPTC	2.1875–3.0625 lb a.i.	12	0
(Eptam) 7E	2.5–3.5 pt		
WSSA MODE OF ACTION GROUP NUMBER[1]: 8			
. . . PLUS . . .			
TRIFLURALIN	0.5–1 lb a.i.	12	0
(Treflan, Trilin)	1–2 pt		
WSSA MODE OF ACTION GROUP NUMBER[1]: 3			
COMMENTS: Preplant incorporated. Common beans. For tank mixes, observe directions for use on all labels, and employ the most restrictive limits and precautions.			
D. PENDIMETHALIN	0.7125–1.425 lb a.i.	24	0
(Prowl) H2O	1.5–3 pt		
WSSA MODE OF ACTION GROUP NUMBER[1]: 3			
. . . PLUS . . .			
EPTC		12	0
(Eptam) 7E	Label rates		
WSSA MODE OF ACTION GROUP NUMBER[1]: 8			
COMMENTS: Preplant incorporated. Common and lima beans. For tank mixes, observe directions for use on all labels, and employ the most restrictive limits and precautions.			
E. ETHALFLURALIN	0.465–1.6875 lb a.i.	24	0
(Sonalan)	1.25–4.5 pt		
WSSA MODE OF ACTION GROUP NUMBER[1]: 3			
. . . PLUS . . .			
EPTC	3.0625 lb a.i.	12	0
(Eptam) 7E	3.5 pt		
WSSA MODE OF ACTION GROUP NUMBER[1]: 8			
COMMENTS: Preplant incorporated. Common beans. Higher rates of ethalfluralin for groundcherry and nightshade control only. For tank mixes, observe directions for use on all labels, and employ the most restrictive limits and precautions.			
POSTPLANT			
After weeds emerge			
A. BENTAZON			
(Basagran)	Label rates	48	30
WSSA MODE OF ACTION GROUP NUMBER[1]: 6			
COMMENTS: Can be used only in beans that are sprinkler irrigated. Apply to broadleaf weeds when they are small (see label) and actively growing after the first trifoliate leaf on the bean crop has expanded. Do not cultivate 5 days before or 7 days after application. Not labeled for cowpeas (blackeyes) and not recommended for adzuki beans.			
B. SETHOXYDIM			
(Poast)	Label rates	12	30
WSSA MODE OF ACTION GROUP NUMBER[1]: 1			
COMMENTS: Systemic grass herbicide that provides good control of volunteer cereals, especially if beans have followed a grain crop.			

Herbicide common name (trade name)	Amount / Acre	R.E.I.+ (hours)	P.H.I.+ (days)
C. CLETHODIM			
(Select Max)	Label rates	24	30
WSSA MODE OF ACTION GROUP NUMBER[1]: 1			
COMMENTS: Systemic herbicide that is safe to beans and controls grass weeds. Must be used with an oil concentrate.			
PREHARVEST			
A. CARFENTRAZONE			
(Shark)	1–2 fl oz	12	0
WSSA MODE OF ACTION GROUP NUMBER[1]: 14			
COMMENTS: Good coverage is essential for best results. An adjuvant of NIS, COC, or MSO is required.			

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

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1 Group numbers are assigned by the Weed Science Society of America (WSSA) according to different modes of action. Although weeds may exhibit multiple resistance across many groups, mode of action numbers are useful in planning mixtures or rotations of herbicides with different modes of action. For more information, see http://www.hracglobal.com.

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PRECAUTIONS FOR USING PESTICIDES

Pesticides are poisonous and must be used with caution. READ THE LABEL BEFORE OPENING A PESTICIDE CONTAINER. Follow all label precautions and directions, including requirements for protective equipment. Apply pesticides only on the crops or in the situations listed on the label. Apply pesticides at the rates specified on the label or at lower rates if suggested in this publication. In California, all agricultural uses of pesticides must be reported. Contact your county agricultural commissioner for further details. Laws, regulations, and information concerning pesticides change frequently. This publication reflects legal restrictions current on the date next to each pest's name.

Legal Responsibility. The user is legally responsible for any damage due to misuse of pesticides. Responsibility extends to effects caused by drift, runoff, or residues.

Transportation. Do not ship or carry pesticides together with food or feed in a way that allows contamination of the edible items. Never transport pesticides in a closed passenger vehicle or in a closed cab.

Storage. Keep pesticides in original containers until used. Store them in a locked cabinet, building, or fenced area where they are not accessible to children, unauthorized persons, pets, or livestock. DO NOT store pesticides with foods, feed, fertilizers, or other materials that may become contaminated by the pesticides.

Container Disposal. Dispose of empty containers carefully. Never reuse them. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways. Consult your county agricultural commissioner for correct procedures for handling and disposal of large quantities of empty containers.

Protection of Nonpest Animals and Plants. Many pesticides are toxic to useful or desirable animals, including honey bees, natural enemies, fish, domestic animals, and birds. Crops and other plants may also be damaged by misapplied pesticides. Take precautions to protect nonpest species from direct exposure to pesticides and from contamination due to drift, runoff, or residues. Certain rodenticides may pose a special hazard to animals that eat poisoned rodents.

Posting Treated Fields. For some materials, *restricted entry intervals* are established to protect field workers. Keep workers out of the field for the required time after application and, when required by regulations, post the treated areas with signs indicating the safe re-entry date. Check with your county agricultural commissioner for latest restricted entry interval.

Preharvest Intervals. Some materials or rates cannot be used in certain crops within a specified time before harvest. Follow pesticide label instructions and allow the required time between application and harvest.

Permit Requirements. Many pesticides require a permit from the county agricultural commissioner before possession or use. When such materials are recommended, they are marked with an asterisk (*) in the treatment tables or chemical sections of this publication.

Processed Crops. Some processors will not accept a crop treated with certain chemicals. If your crop is going to a processor, be sure to check with the processor before applying a pesticide.

Crop Injury. Certain chemicals may cause injury to crops (phytotoxicity) under certain conditions. Always consult the label for limitations. Before applying any pesticide, take into account the stage of plant development, the soil type and condition, the temperature, moisture, and wind. Injury may also result from the use of incompatible materials.

Personal Safety. Follow label directions carefully. Avoid splashing, spilling, leaks, spray drift, and contamination of clothing. NEVER eat, smoke, drink, or chew while using pesticides. Provide for emergency medical care IN ADVANCE as required by regulation.